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of
Agricultural Research, Pusa.

BULLETIN OF THE IMPERIAL INSTITUTE

A RECORD OF PROGRESS RELATING TO
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INDUSTRIES, WITH SPECIAL REFERENCE TO
THE UTILISATION OF THE RAW MATERIALS
OF THE DOMINIONS, COLONIES AND INDIA

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REPORTS OF RECENT INVESTIGATIONS AT THE IMPERIAL INSTITUTE

Selected from the Reports made to the Dominion, Colonial and Indian Governments

TEAS FROM NYASALAND—IV

IN connection with the efforts to improve the quality of Nyasaland tea which have been made in recent years by local planters in association with the Department of Agriculture, a large range of samples prepared on different estates have been investigated at the Imperial Institute. The results of examination of some of these samples have already been recorded in this BULLETIN (1931, **29**, 271; 1932, **30**, 263, 434),[1] and the remaining results, together with a discussion of the whole of the samples hitherto received, are given in the following pages.

The estates on which the teas were prepared were designated by letters, except in the case of the first lot received, which was dealt with in this BULLETIN (1931, **29**, 271). In the general discussion given subsequently this estate has been called "X." Samples from the same estate have been received at different times and each set has been given a new identification letter. In all, seven estates have been concerned in this work, the letters allotted to them being as follows :—(1) X, D, I, L; (2) A, H; (3) B, F/R, J/R; (4) C; (5) E; (6) F/L, J/D; (7) G, K.

The samples were submitted to firms of (*a*) brokers and (*b*) importers at various dates between May 1931 and September 1933. In order to compare the valuations of the teas throughout this period it is necessary to take into

---

[1] The brokers' valuations given on p. 438 of the last report should read as follows: A—1*s*. 4*d*. to 1*s*. 5*d*.; B—1*s*. to 1*s*. 2*d*.; C—1*s*. 2*d*. to 1*s*. 3*d*.

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consideration the extent to which the market fluctuated. At the request of the Imperial Institute the firms in question have kindly furnished the following information on this point.

(*a*) *Brokers.*—The following table shows the average prices realised for Nyasaland teas at sales on or about the dates when the valuations for the various samples were given :

Date of valuation.	Average price per lb. *d.*	Date of sale.
May 19, 1931	6·83	May 18, 1931
June 9, 1932	5·83	June 8, 1932
July 29, 1932	6·53	July 25, 1932
January 23, 1933	6·92	January 18, 1933
May 11, 1933	7·76	May 8, 1933
June 26, 1933	8·30	June 19, 1933
September 4, 1933	9·90	September 4, 1933

(*b*) *Importers.*—" For the purpose of estimating the market fluctuation, it is necessary to divide the teas reported on into two classes :

" 1. Teas without tip and leaf appearance, and more or less generally valued under 1*s.*

" 2. Teas with tip and style, and more or less generally valued over 1*s.*

" Under No. 1 category there has been a total fluctuation of 4*d.* per lb. increase from June 10, 1932, to September 7, 1933. This fluctuation is detailed as follows :

CATEGORY NO. 1. INCREASE OF 4*d.* PER LB. FROM JUNE 10, 1932, TO SEPTEMBER 7, 1933

10·6·32 to 29·7·32.	29·7·32 to 15·5·33.	15·5·33 to 28·6·33.	28·6·33 to 7·9·33.
No change	Advance of 2¼*d.* per lb.	No change	Advance of 1¾*d.* per lb.

" In other words, teas valued at 6*d.* to 6½*d.* in our report of June 10, 1932, are, by comparison, equal in value to teas valued at 10*d.* to 10½*d.* on September 7, 1933.

" With reference to category No. 2, this is more difficult to estimate, but after careful consideration of facts, we find that the market for tippy and stylish teas has fallen by approximately 4*d.* per lb. during the period under review. This 4*d.* decline is only an approximate figure, and is nothing like so clear-cut as the *4d.* advance on category No. 1. We think, however, that for the purposes of your investigation, the figures shown below will be satisfactory :

CATEGORY NO. 2. DECLINE OF *4d.* PER LB. FROM JUNE 10, 1932, TO SEPTEMBER 7, 1933

10·6·32 to 29·7·32.	29·7·32 to 15·5·33.	15·5·33 to 7·9·33.
No change	Decline of *3d.* per lb.	Decline of *1d.* per lb.

" In other words, tippy teas valued at 1*s.* *4d.* to 1*s.* 8*d.* for June 1932 are more or less equal by comparison with teas valued at 1*s.* to 1*s.* *4d.* for September 1933."

Descriptions of Samples and Commercial Opinions

ESTATE E

Four samples, stated to represent bulk teas made during October 1932, were forwarded to the Imperial Institute in November 1932. The samples consisted of black tea, and were labelled respectively Orange Pekoe, Broken Pekoe, Broken Orange Pekoe and Broken Pekoe Souchong.

Details of Manufacture

(1) *Withering,* rolled when ready.

(2) *Rolling,* 6 times ; 1st roll no pressure ; 2nd, slight pressure ; 3rd, 4th, 5th, 6th rolls, pressure cap down 10 minutes and no pressure 10 minutes ; each roll 30 minutes.

(3) *Fermenting,* when ready, last roll going straight to drier.

(4) *Fired* at 200° ; if not dry on coming out of drier returned and finished at 180°.

(5) *Soil,* red clay.

(6) *Jat.*—Local jat only ; B.O.P. is made from all siftings of green leaf sifter.

Commercial Value

(*a*) ***Brokers.***

" The Broken Orange Pekoe is really only a Broken Pekoe grade. We do not know how many rolls this tea is taken from, but would advise taking fine leaf from only the first two rolls for the Broken Orange Pekoe. The Broken Pekoe is even and is a much better type than the Broken Orange Pekoe ; in fact it looks to us as if the samples may have been mismarked. The Orange Pekoe is well twisted, but there is some stalk noticeable. The Broken Pekoe Souchong is greyish in colour and rather too large in size.

" The liquors, though on the light side, are fresh and sweet. The infused leaf, though a little mixed, is fairly bright.

" We advise cutting the Broken Pekoe Souchong to a somewhat smaller size and making a finer Broken Orange Pekoe ; otherwise the manufacture seems to be satisfactory."

The firm valued the four samples as follows :

Sample.	Value. *Per lb.*
Broken Orange Pekoe	6¾*d.*
Broken Pekoe	7*d.*
Orange Pekoe	6¾*d.*–7*d.*
Broken Pekoe Souchong	6½*d.*

(*b*) *Importers.*

" We have carefully examined the four samples of Nyasaland tea. The predominant feature is that the liquors are all severely ' weather damaged.' This may have occurred after manufacture and while the teas were lying in the factory ready for despatch. It is difficult to describe the result of this ' weather damage,' and the nearest we can say is that it gives the teas a ' chinary ' and slightly smoky character with a background of coarseness familiar with rain.

" There is one point of note in this ' weather damage,' and that is that the O.P. is much less affected than the other grades. This may be due to the fact that it has been much more rolled than the other grades. Apart from this unpleasant character in the liquors, the teas are plain with no quality or colour. Without exception, the liquors are thin and weak, although bright in appearance. The infusions of all samples lead us to conclude that the withering and fermentation have both been carried out very satisfactorily and that little or no improvement can be made in this direction.

" We can find little in the samples that points to firing faults, unless perhaps the slightly smoky character mentioned above is due to over-firing.

" The only other point which calls for attention is the leaf appearance of all grades. This is definitely bad from a market point of view. None of the samples is true to grade, the B.O.P. and B.P. have no style or appearance and could be interchanged without detriment. The O.P. is ragged and contains far too much stalk.

" Bearing in mind the information you have given us we are of the opinion that with the exception of the 'weather damage' the manufacture has made the best of the tea at its disposal. The brightness and even colour of the liquors and infusions are sufficient to convince us of this. The 'weather damage' has spoiled the teas, and if it can be traced to either before or after manufacture we think the resulting teas should show a marked improvement."

ESTATE F/R

Four samples, consisting respectively of Broken Pekoe, Pekoe, Orange Pekoe and Broken Orange Pekoe leaf, were forwarded in January 1933.

It was stated that these teas were produced before the middle of November 1932, mainly during hot dry weather. The flush was considerably overgrown during a part of the time when the samples were picked.

Details of Manufacture

(1) *Withering*, 16 to 19 hours.

(2) *Rolling.*—1st roll, 30 minutes without pressure; 2nd roll, 30 minutes light to medium pressure; 3rd roll, 30 minutes medium to hard pressure, 10 minutes on and 5 off; 4th roll, 30 minutes full pressure, 10 minutes on and 5 off. The leaf was sifted after each rolling and the fine tea extracted and put aside to ferment. Each sifting period took 15 minutes.

(3) *Fermentation.*—Fine bulk, 3 to 3½ hours. Coarse bulk, 3 hours 20 minutes to 3¾ hours.

(4) *Fired* in one operation at a temperature of 190–195° in a " pressure " machine.

Commercial Value

(*a*) *Brokers*

" The Broken Orange Pekoe is a useful type, with some tip showing. The Broken Pekoe unfortunately contains a large percentage of dust and fannings and this detracts from its value. The Orange Pekoe is well twisted. The Pekoe is really a large Broken Pekoe Souchong. The firing is satisfactory.

" The liquors rather lack colour but are bright.

" The infused leaf, though rather green, is quite bright.

" We think that these teas might have been better with a rather harder wither.

" Valuations :

	Per lb.
Broken Pekoe	7¾*d.*–8*d.*
Pekoe	8*d.*
Orange Pekoe	7¾*d.*–8*d.*
Broken Orange Pekoe . . .	8½*d.*–9*d.*

(*b*) *Importers.*

" Considerable care seems to have been taken in obtaining leaf appearance. All four samples are very true to grade, but the leaf is so very black in colour that a poor and possibly burnt liquor is at once indicated. Upon examination this is found to be so. All liquors are dull and very plain and, in addition, are burnt or highly fired. This is particularly noticeable in the broken grades. Cup quality is entirely lacking, and apart from the usual coarseness generally associated with Nyasaland tea, the samples have no outstanding character. Present values are as follows :

	Per lb.
Broken Pekoe	8*d.*
Pekoe	8*d.*
Orange Pekoe	8½*d.*
Broken Orange Pekoe . . .	8½*d.*

ESTATE F/L

Three samples, consisting respectively of Orange Pekoe, Broken Pekoe and Broken Orange Pekoe leaf were forwarded in January 1933. The teas were produced before the middle of November 1932, mainly during hot dry weather.

Details of Manufacture

(1) *Withering*, 18 to 20 hours.

(2) *Rolling.*—1st roll, 20 minutes, no pressure; 2nd roll, 20 minutes, slight pressure; 3rd roll, 20 minutes, half pressure; 4th roll, 20 minutes, full pressure for 3 minutes and no pressure for 1 minute.

(3) *Fermentation.*—Fine dool 2½ hours (time taken from commencement of rolling). Coarse dool 3 to 3½ hours (time taken from commencement of rolling).

(4) *Fired* at a temperature of 190–200° in one operation.

Commercial Value

(*a*) *Brokers.*

" The Broken Orange Pekoe is even, with some pale tip showing. The Broken Pekoe is clean and true to type. The Orange Pekoe has very fair twist. The firing is satisfactory.

" The liquors, though light, are bright with fair flavour.

" The infused leaf is even and quite bright.

" These teas represent satisfactory manufacture.

" Valuations :

	Per lb.
Orange Pekoe	8*d.*
Broken Pekoe	8*d.*–8½*d.*
Broken Orange Pekoe	8½*d.*"

(*b*) *Importers.*

" Leaf appearance again seems to have taken prior place during manufacture and is very similar to the teas from Estate F/R except that the Broken Orange Pekoe has a slightly better appearance and a more golden colour. The liquors of the three teas from this estate are, however, considerably inferior to F/R as they are very 'chinary' in character and are dull and coarse. No high firing is noticeable, but this may be hidden by the China flavour. The values are as follows :

	Per lb.
Orange Pekoe	8*d.*
Broken Pekoe	7½*d.*
Broken Orange Pekoe	8½*d.*"

ESTATE G

Seven samples, prepared on December 17, 1932, were forwarded in January 1933.

The teas consisted of three samples of Broken Orange Pekoe, three of Broken Pekoe and a sample representing a blend of made tea, made up from a mixture of jats and grades after manufacture.

Details of Manufacture

Indian Samples, Nos. 1 (B.O.P.) and 2 (B.P.).

Withering.—Withered for 25½ hours ; loss of moisture 44 per cent. Temperature of loft, maximum 75°, minimum 68°.

Rolling.—Speed 50 revs. per minute. Weather dry and hot. Outside temperature, maximum 86°, minimum 77°. Physical condition of leaf: cool, clammy and sticky ; considered excellent.

> *1st roll,* 25 minutes without pressure. Temperature of rolling room, wet bulb 79°, dry bulb 84°. Temperature of discharged leaf 87°.
>
> *2nd roll,* 25 minutes light pressure. Temperature of rolling room, wet bulb 80°, dry bulb 84°. Temperature of discharged leaf 90°.
>
> *3rd roll,* 25 minutes medium pressure, 5 minutes on, 2 minutes off. Temperature of rolling room, wet bulb 78°, dry bulb 83°. Temperature of discharged leaf 90°.
>
> *4th roll,* 25 minutes medium heavy pressure, 4 minutes on, 2 minutes off. Temperature of rolling room, wet bulb 78°, dry bulb 82°. Temperature of discharged leaf 90°.
>
> *5th roll,* 25 minutes heavy pressure, 3 minutes on, 2 minutes off. Temperature of rolling room, wet bulb 75°, dry bulb 80°. Temperature of discharged leaf 90°.
>
> *6th roll,* 25 minutes heavy pressure, 3 minutes on, 2 minutes off. Temperature of rolling room, wet bulb 75°, dry bulb 81°. Temperature of discharged leaf 89°.

Fermentation.—Fine siftings 4 hours 40 minutes ; coarse bulk 4 hours 5 minutes. Temperature at floor level in both cases 85°.

Firing.—Fine siftings, down-draught drier-fired at 180° in one operation. Coarse bulk, fired in Sirocco E.C.P. drier in two operations ; first firing at 200°, second firing at 180°.

Local Samples, Nos. 3 (*B.O.P.*) *and* 4 (*B.P.*).

Withering.—Withered for 26½ hours ; loss of moisture 40 per cent. Temperature of loft, maximum 75°, minimum 68°.

Rolling.—Speed 50 revs. per minute. Physical condition of leaf : considered not in as good condition as the Indian leaf (Samples 1 and 2).

1st roll, 35 minutes without pressure. Temperature of rolling room, wet bulb 81°, dry bulb 85°. Temperature of discharged leaf 91°.

2nd roll, 25 minutes light pressure. Temperature of rolling room, wet bulb 78·5°, dry bulb 83°. Temperature of discharged leaf 91°.

3rd roll, 25 minutes medium pressure, 5 minutes on, 2 minutes off. Temperature of rolling room, wet bulb 78°, dry bulb 82°. Temperature of discharged leaf 91°.

4th roll, 25 minutes medium heavy pressure, 4 minutes on, 2 minutes off. Temperature of rolling room, wet bulb 75°, dry bulb 80°. Temperature of discharged leaf 90·5°.

5th roll, 25 minutes heavy pressure, 3 minutes on, 2 minutes off. Temperature of rolling room, wet bulb 75°, dry bulb 80°. Temperature of discharged leaf 89°.

6th roll, 25 minutes heavy pressure, 3 minutes on, 2 minutes off. Temperature of rolling room, wet bulb 75°, dry bulb 80°. Temperature of discharged leaf 90°.

Fermentation.—Fine siftings 3 hours 35 minutes. Coarse bulk 4 hours 20 minutes. Temperature at floor level in both cases 85°.

Firing.—Fine siftings, down-draught drier-fired at 180° in one operation. Coarse bulk, fired in Sirocco E.C.P. drier in two operations ; first firing at 200°, second firing at 180°.

Mixed Samples, Nos. 5 (B.O.P.) and 6 (B.P.).

Withering.—Withered for 22 hours. Loss of moisture: Indian leaf, 45·4 per cent.; Local leaf, 41 per cent. Temperature of loft, maximum 75°, minimum 68°.

Rolling.—Speed 50 revs. per minute. Physical condition of leaf: cool, clammy and sticky. Indian leaf felt harder withered than local.

1st roll, 35 minutes without pressure. Temperature of rolling room, wet bulb 78°, dry bulb 83°. Temperature of discharged leaf 86°.

2nd roll, 25 minutes light pressure. Temperature of rolling room, wet bulb 78°, dry bulb 88°. Temperature of discharged leaf 86°.

3rd roll, 25 minutes medium pressure, 5 minutes on, 2 minutes off. Temperature of rolling room, wet bulb 77°, dry bulb 82°. Temperature of discharged leaf 87°.

4th roll, 25 minutes medium heavy pressure, 4 minutes on, 2 minutes off. Temperature of rolling room, wet bulb 79°, dry bulb 83°. Temperature of discharged leaf 87°.

5th roll, 25 minutes heavy pressure, 3 minutes on, 2 minutes off. Temperature of rolling room, wet bulb 80°, dry bulb 84°. Temperature of discharged leaf 88°.

6th roll, 25 minutes heavy pressure, 3 minutes on, 2 minutes off. Temperature of rolling room, wet bulb 78°, dry bulb 85°. Temperature of discharged leaf 91°.

Fermentation.—Fine leaf, 4 hours 25 minutes; temperature at floor level 86°. Coarse bulk, 5 hours; temperature at floor level 82°.

Firing.—Fine siftings, down-draught drier-fired at 180° in one operation. Coarse bulk, fired in Sirocco E.C.P. drier in two operations; first firing at 200°, second firing at 180°.

Mixed Sample No. 7.—This is a blend of made tea, made up from a mixture of jats and grades after manufacture. A report on its liquoring quality was desired in comparison with sample No. 6.

Commercial Value

(*a*) *Brokers.*

" Of the three Broken Orange Pekoes the No. 3 (Local) is easily the best, having a good show of bright golden tip. The tip of the No. 1 Broken Orange Pekoe (Indian) is paler in colour and is in much smaller quantity. The mixture No. 5 Broken Orange Pekoe is a satisfactory tea. The No. 2 Broken Pekoe (Indian) is a very useful type, being black in colour, clean and even. The No. 4 Broken Pekoe (Local) though not quite so black, is also a very useful even type. The mixture No. 6 Broken Pekoe, though not quite as black as the No. 2 Broken Pekoe, is also a very useful type. The No. 7 sample unfortunately contains a large percentage of small fannings leaf which detracts from its value. The firing is satisfactory.

" In liquor the No. 3 Broken Orange Pekoe (Local) is easily the best, No. 5 (mixed) being second and No. 1 (Indian) the worst, being lighter and not so bright as the other two. These remarks also apply to the three Broken Pekoes. The No. 7 (blended) sample has better colour and is rather brighter than No. 6.

" We think that these teas would have been improved by shorter fermentation. Three hours and 30 minutes should be ample for the fine mal and 4 hours for the coarse leaf at a temperature of 85°.

" The infused leaf of No. 1 (Indian) is fairly bright, No. 2 (Indian) is dull, No. 3 (Local) is even and bright, No. 4 (Local) is only fair and inclined to be dull, No. 5 (mixed) is fairly bright, No. 6 (mixed) is duller than No. 4, No. 7 (blended) is rather brighter than No. 6.

" Valuations :

	Per lb.
1. Indian Broken Orange Pekoe .	1*s*.
2. Indian Broken Pekoe . .	8*d*.–8½*d*.
3. Local Broken Orange Pekoe .	1*s*. 6*d*.–1*s*. 8*d*.
4. Local Broken Pekoe . .	8½*d*.
5. Mixed Broken Orange Pekoe .	1*s*. 3*d*.–1*s*. 4*d*.
6. Mixed Broken Pekoe . .	8*d*.–8½*d*.
7. Blended sample . . .	8*d*.–8½*d*.

(*b*) *Importers.*

" 1. *Indian Broken Orange Pekoe.*—This is fairly tippy, but has a very black background, and the tip is pale in colour. Both these points are bad from a tea point of view, and detract from the value of the tea. The liquor of this tea is fairly bright, but is plain and without flavour and slightly over-fired.

" 2. *Indian Broken Pekoe.*—This has a milled black leaf, and the liquor is poor, dull and very coarse. This coarseness may possibly be due to rain.

" 3. *Local Broken Orange Pekoe.*—This has the best tip and leaf appearance of all samples submitted. The tip is more golden, and the background is browner and therefore more attractive. The liquor is unfortunately a little ' chinary ' and coarse, and must be regarded as inferior to that of sample 1 from this estate.

" 4. *Local Broken Pekoe.*—This is very similar in appearance to No. 2 (Indian Broken Pekoe) from this estate, but the liquor is rather better, being brighter and less coarse and nasty.

" 5. *Mixed Broken Orange Pekoe.*—The tip and leaf appearance of this sample is between that of No. 1 (Indian Broken Orange Pekoe) and No. 3 (Local Broken Orange Pekoe). As regards the liquor, however, it is the best of all the samples submitted. There is a very slight flavour, but the liquor is rather light and weak, although it has no nasty character.

" 6 *and* 7. *Mixed Broken Pekoe and the Blended Sample.*—As requested, these two samples have been compared. They are entirely different from each other, both in leaf and liquor. This makes a comparison difficult, but we hope that the following notes may be of help :

" The leaf of No. 6 is milled and black. This is against its value, so that the Blended sample No. 7, which is natural and unmilled, is better from this point of view. The liquor of the Blended sample is also rather better, as it has more colour and thickness, and as a broken grade is more usable on this account. The Mixed Broken Pekoe sample No. 6 is thin, weak and in addition has been burnt during manufacture.

"The values of the samples are as follows :

	Per lb.
1. Indian Broken Orange Pekoe	10*d.*
2. Indian Broken Pekoe	7¾*d.*–8*d.*
3. Local Broken Orange Pekoe	11½*d.*
4. Local Broken Pekoe	8*d.*
5. Mixed Broken Orange Pekoe	10¾*d.*–11*d.*
6. Mixed Broken Pekoe	7¾*d.*–8*d.*
7. Blended sample	8½*d.*

ESTATE H

Seven samples, prepared on December 13, 1932, were forwarded in January 1933.

The samples consisted of Broken Pekoe, Pekoe, Orange Pekoe and Broken Orange Pekoe leaf.

Details of Manufacture

Indian Samples, Nos. 277 (*B.O.P.*), 278 (*P.*) *and* 279 (*B.P.*).

(1) *Withering*, 27½ hours. The leaf came in wet owing to heavy rain, and withering did not commence for some hours as the withering loft fans were out of commission.

(2) *Rolling.*—1st roll, 30 minutes light pressure; 2nd roll, 20 minutes medium pressure, 10 minutes light pressure; 3rd, 4th and 5th rolls, 20 minutes hard pressure, 10 minutes light pressure. Temperature of rolling room, maximum 82°, minimum 77°. Humidity of rolling room, maximum 63 per cent., minimum 61 per cent. The average temperature of the leaf dropped from the rolling tables was 85°.

(3) *Fermentation.*—4 hours. Temperature of fermenting room, maximum 80°, minimum 76°, Humidity of fermenting room, maximum 70 per cent., minimum 65 per cent.

(4) *Firing.*—Inlet temperature 200°.

Local Samples, Nos. 280 (*F.B.O.P.*), 281 (*B.O.P.*), 282 (*P.*), 283 (*B.P.*).

(1) *Withering*, 22½ hours (see note above regarding conditions of withering).

(2) *Rolling.*—1st roll, 30 minutes light pressure; 2nd roll, 20 minutes medium pressure, 10 minutes light pressure; 3rd, 4th and 5th rolls, 20 minutes hard pressure, 10

minutes light pressure. Temperature of rolling room, maximum 82°, minimum 77°. Humidity of rolling room, maximum 63 per cent., minimum 61 per cent.

(3) *Fermentation.*—3½ hours. Temperature of fermenting room, maximum 80°, minimum 76°. Humidity of fermenting room, maximum 70 per cent., minimum 65 per cent.

(4) *Firing.*—Inlet temperature 200°.

Commercial Value

(*a*) *Brokers.*

" The Flowery Broken Orange Pekoe (Local) is mixed, small in size and rather open, with a few tips showing. The Local Pekoe is an even Broken Pekoe Souchong. The Local Broken Pekoe, though grey, is even. The Indian Broken Orange Pekoe is really triturated fannings. The Indian Pekoe is not quite so stylish as the Local Pekoe. The Indian Broken Pekoe is similar to the Local Broken Pekoe, but the Local Broken Orange Pekoe has distinctly inferior style to the Indian, being grey and dusty mixed. The firing is quite satisfactory.

" The liquors of the Local samples are better than the others, being distinctly brighter.

" The infused leaf of the Local samples is fairly bright, that of the Indian manufacture being dullish.

" In our opinion the shorter withering and fermentation given to the Local samples has contributed largely to their better quality, and even shorter withering might be resorted to with advantage.

" Valuations :

		Per lb.
280.	Local Flowery Broken Orange Pekoe	8¼*d.*
281.	Local Broken Orange Pekoe	7¾*d.*
282.	Local Pekoe	8*d.*
283.	Local Broken Pekoe	7¾*d.*–8*d.*
277.	Indian Broken Orange Pekoe	8*d.*
278.	Indian Pekoe	7¾*d.*–8*d.*
279.	Indian Broken Pekoe	7¾*d.*–8*d.*

(*b*) *Importers.*

" The three Local samples 280, 282 and 283 are generally inferior to the Indian samples and the Local sample 281. They are coloury plain teas with no quality and of a slight China and coarse character. The Indian samples *277*, *278*, *279* and Local 281 are coloury thick plain teas, without China character, and without any trace of high firing. The leaf appearances of these samples is, however, poor, and it appears that the grades have been made by grinding or milling the leaf up.

" The values are as follows :

	Per lb.
280. Local Flowery Broken Orange Pekoe	8¼*d*.
281. Local Broken Orange Pekoe . .	8*d*.–8¼*d*.
282. Local Pekoe	7¾*d*.
283. Local Broken Pekoe . . .	7¾*d*.–8*d*
277. Indian Broken Orange Pekoe . .	8*d*.–8¼*d*.
278. Indian Pekoe	8*d*.
279. Indian Broken Pekoe . . .	7¾*d* –8*d*.

ESTATE I

Two samples, consisting respectively of Broken Orange Pekoe and Pekoe leaf, prepared between December 10 and 21, 1932, were forwarded in January 1933.

Details of Manufacture, etc.

Plucking conditions.—9·57 inches of rain fell on 8 days during the period (2·55 inches on December 12 and 2·27 inches on December 18). Age of flush 7 to 8 days.

Wither.—Natural wither, no fans available. Average time about 22 hours, varying from 18 to 26 hours according to weather conditions. Average loss of moisture 45 per cent. Maximum temperature on lofts 92°, minimum 70°.

Rolling.—1st roll, 30 minutes no pressure ; 2nd roll, 30 minutes very light pressure ; 3rd roll, 30 minutes, 10 minutes medium pressure and 10 minutes no pressure; 4th, 5th and 6th rolls, 20 minutes, 10 minutes hard pressure and 10 minutes no pressure. Average temperature of rolling room 77°. Average humidity 79 per cent.

Fermentation.—Leaf spread on cement beds. Fine bulk 1¼ inches, thick coarse bulk 1½ inches. Fine bulk fermented 3¼ to 3¾ hours and coarse bulk 3¾ to 4¼ hours, according to conditions. Average temperature of fermenting room 78°. Average humidity 83 per cent.

Firing.—In two operations. First firing at 200°, final firing at 185°. Average time in driers, 14 to 18 minutes.

Sorting.—Teas sorted over Michie sifters.

Commercial Value

(*a*) *Brokers.*

" The Broken Orange Pekoe is a useful grade, being quite stylish, with fair tip. The Pekoe is greyish and rather small in size.

" The liquors are coloury, but are not very bright.

" The infused leaf is only of fair colour.

" The leaf feels rather soft and spongy and the teas do not smell fresh enough. The firing has not been very satisfactorily carried out and this is probably the cause of the lack of brightness in the liquors, fermentation not having been arrested quickly enough.

Valuations :

	Per lb.
Broken Orange Pekoe	8½*d.*
Pekoe	7¾*d.*–8*d.*

(*b*) *Importers.*

" The infusions of these teas are dull and poor, and the liquors dull, rainy and very coarse. The Broken Orange Pekoe has a few tips, but the background is very black and the leaf generally very mixed. The Pekoe is fairly true to grade, and has an even, fairly well made leaf. The liquor, however, is so thin and coarse as to relegate the tea to below present common tea price. The values are as follows :

	Per lb.
Broken Orange Pekoe	8*d.*
Pekoe	7½*d.*

ESTATES J/R AND J/D

Seven samples prepared on these two estates were forwarded in March 1933.

Details of Manufacture, etc.

Samples J/R1, J/R2, J/R3, J/R4 (leaf of 7 days' growth, manufactured between February 1 and 13, 1933).

(1) *Withering.*—Soft to medium.

(2) *Rolling.*—1st roll, 30 minutes no pressure ; 2nd roll, 30 minutes slight to medium pressure ; 3rd roll, 30 minutes

medium to hard pressure, 10 minutes on and 5 minutes off; 4th roll, 30 minutes hard pressure, 10 minutes on and 5 minutes off.

(3) *Fermentation.*—Fine bulk, 2 hours 50 minutes to 3 hours 10 minutes. Coarse bulk, 3¼ to 3½ hours.

(4) *Firing.*—Twice in E.C.P. machine, temperature 185° to 190°.

Samples J/D1, J/D2, J/D3 (manufactured during the first two weeks of February 1933).

(1) *Withering.*—Varied from 18 to 24 hours.

(2) *Rolling.*—1st roll, 20 minutes; 2nd roll, 20 minutes; 3rd roll, 20 minutes; 4th roll, 20 minutes.

(3) *Fermentation.*—Fine leaf, 2½ hours. Coarse leaf, 3 hours. The time is taken from the point at which the leaf enters the roller.

(4) *Firing.*—Fired at 200° to 210° in Paragon driers in one operation.

Commercial Value

(*a*) *Brokers.*

" Sample J/R1 (Broken Orange Pekoe) is quite even with some tip showing. J/R2 (Orange Pekoe) is well twisted but has a few stalks. J/R3 (Broken Pekoe) is leafy and also not free from stalk. J/R4 (Pekoe) is rather bold and lacks style; this grade also has a few stalks noticeable.

" The liquors of these four samples have very useful colour and strength. The infused leaf is even and bright.

" Sample J/D1 is a leafy, rather irregular Broken Orange Pekoe with a fair show of tip. J/D2 is a rather irregular stalky Orange Pekoe. J/D3 is a grey leafy Broken Pekoe.

" The liquors of these three lines have a little colour and strength and are quite bright. The infused leaf is rather greenish.

" Valuations :

	Per lb.
J/R1	8¾*d.*
J/R2	8½*d.*
J/R3	8½*d.*
J/R4	8¼*d.*
J/D1	8¾*d.*
J/D2	8½*d.*
J/D3	8¼*d.*

"Comparing the J/D samples with the J/R samples, in style of leaf we prefer the J/R kind, and these are also preferable in cup, having better colour and strength. The firing of both sets is satisfactory. The infused leaf of the J/R samples is also much more even and bright.

"The difference does not show in the valuations, as with the present low market little or no discrimination is shown in the purchase of teas of this description."

(b) Importers.

	Approximate Value. *Per lb.*
Sample J/R1. Small even leaf, some tip, good even-coloured infusion, coloury plain liquor	9¼*d.*
Sample J/R2. Small even leaf, no tip, liquor and infusion as R1	9*d.*
Sample J/R3. Very wiry, well made "leggy" leaf, fair-coloured infusion, thin plain liquor	8½*d.*
Sample J/R4. Choppy flat B.P.S. leaf, bright infusion, fairly coloury plain liquor but little light	8¾*d.*
Sample J/D1. Rather leafy, but even and fairly well made with some tip; dull greenish infusion; coloury dull liquor, rather over-fired character	9*d.*
Sample J/D2. Leafy, even dull greenish infusion, thin plain liquor, no trace of over-firing	8½*d.*
Sample J/D3. Wiry, well-made "leggy" O.P., but not quite so good in appearance as R 3; thin dull liquor	8½*d.*

The firm added that in their opinion the J/R samples are of better quality and cup value than the J/D samples, and that from the London market point of view the former are certainly the more serviceable.

ESTATE K

Six samples from this estate, consisting of Broken Orange Pekoe and Orange Pekoe, were forwarded in March 1933.

Details of Manufacture

Indian Samples, Nos. K1 *(B.O.P.) and K2 (B.P.).*

Withering.—Withered for 21 hours; loss of moisture 49·44 per cent. Temperature of loft, maximum 82°, minimum 68°.

Rolling.—Speed 55 revs. per minute. Weather bright sunshine with slight breeze. Physical condition of leaf: cool, clammy and sticky.

> *1st roll,* 35 minutes without pressure. Temperature of rolling room, wet bulb 76°, dry bulb 80°. Temperature of discharged leaf 88°.

2nd roll, 25 minutes light pressure. Temperature of rolling room, wet bulb 78°, dry bulb 82°. Temperature of discharged leaf 88°.

3rd roll, 25 minutes medium pressure, 5 minutes on, 2 minutes off. Temperature of rolling room, wet bulb 77°, dry bulb 83°. Temperature of discharged leaf 88°.

4th roll, 25 minutes heavy pressure, 4 minutes on, 2 minutes off. Temperature of rolling room, wet bulb 77°, dry bulb 84°. Temperature of discharged leaf 88°.

5th roll, 25 minutes heavy pressure, 3 minutes on, 2 minutes off. Temperature of rolling room, wet bulb 77°, dry bulb 85°. Temperature of discharged leaf 90°.

6th roll, 25 minutes heavy pressure, 3 minutes on, 2 minutes off. Temperature of rolling room, wet bulb 76°, dry bulb 83°. Temperature of discharged leaf 89°.

Fermentation.—Fine siftings 4 hours 45 minutes; coarse bulk 5 hours 5 minutes. Temperature at floor level in both cases 82°.

Firing.—Fine siftings fired in down-draught drier at 180° in one operation. Coarse bulk fired in Sirocco E.C.P. drier in two operations; first firing at 200°, second firing at 180°.

Local Samples, Nos. K3 (B.O.P.) and K4 (B.P.).

Withering.—Withered for 21 hours; loss of moisture 47·15 per cent. Temperature of loft, maximum 82°, minimum 64°.

Rolling.—Speed 55 revs. per minute. Physical condition of leaf: cool, clammy and sticky. Appeared fresher than the Indian leaf (Samples Nos. 1 and 2).

1st roll, 35 minutes without pressure. Temperature of rolling room, wet bulb 78°, dry bulb 82°. Temperature of discharged leaf 88°.

2nd roll, 25 minutes light pressure. Temperature of rolling room, wet bulb 77·5°, dry bulb 83°. Temperature of discharged leaf 89°.

3rd roll, 25 minutes medium pressure, 5 minutes on, 2 minutes off. Temperature of rolling room, wet bulb 77·5°, dry bulb 85°. Temperature of discharged leaf 89°.

4th roll, 25 minutes medium heavy pressure, 4 minutes on, 2 minutes off. Temperature of rolling room, wet bulb 77·5°, dry bulb 85°. Temperature of discharged leaf 90°.

5th roll, 25 minutes heavy pressure, 3 minutes on, 2 minutes off. Temperature of rolling room, wet bulb 77·5, dry bulb 85°. Temperature of discharged leaf 89°.

6th roll, 25 minutes heavy pressure, 3 minutes on, 2 minutes off. Temperature of rolling room, wet bulb 78°, dry bulb 86°. Temperature of discharged leaf 90°.

Fermentation.—Fine siftings 4 hours 45 minutes ; coarse bulk 5 hours 10 minutes. Temperature at floor level in both cases 81°.

Firing.—Fine siftings fired in down-draught drier at 180° in one operation. Coarse bulk fired in Sirocco E.C.P. drier in two operations ; first firing at 200°, second firing at 180°.

Mixed Samples, Nos. K5 (B.O.P.) and K6 (B.P.).

Withering.—Withered for 26 hours ; loss of moisture, Indian leaf 49·3 per cent., Local leaf 48·3 per cent. Temperature of loft, maximum 82°, minimum 64°.

Rolling.—Speed 55 revs. per minute. Physical condition of leaf : cool, clammy and sticky. Indian leaf felt harder-withered than Local.

1st roll, 35 minutes without pressure. Temperature of rolling room, wet bulb 74°, dry bulb 78°. Temperature of discharged leaf 88°.

2nd roll, 25 minutes light pressure. Temperature of rolling room, wet bulb 76°, dry bulb 80°. Temperature of discharged leaf 88°.

3rd roll, 25 minutes medium pressure, 5 minutes on, 2 minutes off. Temperature of rolling room, wet bulb 77°, dry bulb 83°. Temperature of discharged leaf 89°.

4th roll, 25 minutes medium heavy pressure, 4 minutes on, 2 minutes off. Temperature of rolling room, wet bulb 77°, dry bulb 84°. Temperature of discharged leaf 90°.

5th roll, 25 minutes heavy pressure, 3 minutes on, 2 minutes off. Temperature of rolling room, wet bulb 77°, dry bulb 85°. Temperature of discharged leaf 90°.

6th roll, 25 minutes heavy pressure, 3 minutes on, 2 minutes off. Temperature of rolling room, wet bulb 77°, dry bulb 84°. Temperature of discharged leaf 90°.

Fermentation.—Fine siftings 4 hours 45 minutes; coarse bulk 5 hours. Temperature at floor level, fine leaf 82°, coarse bulk 82·5°.

Firing.—Fine siftings fired in down-draught drier at 180° in one operation. Coarse bulk fired in Sirocco E.C.P. drier in two operations ; first firing at 200°, second firing at 180°.

Commercial Value

(*a*) *Brokers.*

" In leaf the Local Broken Orange Pekoe is best, having a very fair show of bright tip ; the Mixed is second, and the Indian third. In the case of the Broken Pekoes in leaf there is nothing to choose between the three samples.

" The Indian samples have the best liquors, the Mixed are second and the Local are the worst, being distinctly lighter. The Broken Orange Pekoes have useful colour and strength and are bright ; the Broken Pekoes have fair colour though they are rather soft and plain.

" The infused leaf of all the Broken Orange Pekoes is even and bright, that of the Broken Pekoes being dullish.

" We would advise shorter fermentation, especially for the coarse mal. This should give brighter liquors without loss of colour.

" Valuations :

		Per lb.
K1.	Indian Broken Orange Pekoe	10*d.*
K2.	Indian Broken Pekoe . .	8¼*d.*
K3.	Local Broken Orange Pekoe .	11*d.*–1*s.*
K4.	Local Broken Pekoe . .	8¼*d.*
K5.	Mixed Broken Orange Pekoe	10½*d.*
K6.	Mixed Broken Pekoe . .	8¼*d.*

(*b*) *Importers.*

	Approximate value *Per lb.*
*Sample K*1. A very fair quantity of tip, a small even leaf, black in appearance, thick coloury dull liquor, of plain quality; even-coloured infusion	11*d.*
*Sample K*2 Chopped Pekoe and/or B.P.S. leaf, very black in colour, rather dull infusion, thin dull liquor	8½*d.*
*Sample K*3. Very good tip, with rather brownish background, which incidentally adds to its value; good coloury thick liquor of some quality; bright good-coloured infusion	1*s.* 2*d.*
*Sample K*4. Milled or chopped leaf; thin poor quality liquor	8¼*d.*–8½*d.*
*Sample K*5. Rather more tip than K1, and rather inferior liquor to K1 and 3, being a shade light and coarse; the infusion is fairly even-coloured but a little dullish and again inferior to K1 and 3	1*s.*
*Sample K*6. Chopped or milled leaf, very black in colour, slightly preferable to K4 in leaf appearance and liquor, although the latter is again thin and dullish	8½*d*–8¾*d.*

" If a comparison is needed between the three sets of K samples, viz. Indian, Local and Mixed, the final result is of course governed mainly by the quantity of tip present in the Broken Orange Pekoes of each type. From a liquor point of view the Indian samples are undoubtedly the best, and the mixtures of the Indian and Local second-best. The Local samples have far and away the best tip in the Broken Orange Pekoe, but the quality of the Broken grade (K4) is slightly worse than the same grade from the other two types.

" With reference to the Broken grade in the three sets of samples, we feel that much better results could be obtained if the size of the leaf was natural, and not artificially milled or chopped. We think we have already expressed our views on this matter in earlier reports, and we again emphasise the point from the point of view of marketable value in London."

ESTATE L

Eight samples of tea, consisting of Broken Orange Pekoe and Broken Pekoe Souchong, were forwarded in June 1933.

Details of Manufacture, etc.

A (*B.O.P.*) *and A*1 (*B.P.S.*).—From bushes grown from acclimatised local seed. Planted in Feb.–March 1925.

B (B.O.P.) and B1 (B.P.S.).—Composed of 25 per cent. imported Manipuri jat and 75 per cent. local jat. Planted in Feb.–March 1925.

C (B.O.P.) and C1 (B.P.S.).—Composed of equal quantities of leaf from the local and Manipuri gardens. Planted in Feb.–March 1925. Mixed before withering.

D (B.O.P.) and D1 (B.P.S.).—From an imported Manipuri jat planted Feb.–March 1925.

Plucking Conditions.—Age of flush on fields 8 days.

During those 8 days 2·80 inches of rain fell. No rain fell on the day the leaf was plucked. The humidity at 8 a.m. was 80 per cent.

Samples A and A1.

Withered 23 hours. Loss of moisture 44 per cent.

Temperature of leaf lofts: maximum 95°, minimum 65°.

Rolling.

1st roll, 30 minutes, no pressure.

2nd roll, 30 minutes very light pressure, on and off.

3rd roll, 5 minutes no pressure, 15 minutes pressure, 10 minutes no pressure.

4th roll, 20 minutes; 5 minutes pressure, 5 minutes no pressure.

5th roll, 20 minutes; 5 minutes pressure, 5 minutes no pressure.

6th roll, 20 minutes; 5 minutes pressure, 5 minutes no pressure.

Average temperature of rolling room, 78°.

Average humidity about 75 per cent.

Leaf is sifted in a Jackson ball breaker, and fine bulk taken direct to fermenting room.

Fermentation.—Leaf spread on cement beds.

Fine bulk, 1¼ inches thick. Coarse, 1¾ inches.

Fine bulk fermented 3½ hours. Coarse bulk, 4 hours.

Average temperature of fermenting room, 75°.

Humidity 75 per cent.

Firing.—Done in two operations in Paragon driers at temperatures 205° and 185°. Operation 15 minutes in each drier.

Samples B and B1.

Conditions the same as A and A1, with the following alterations:

Withered 23½ hours.

Loss of moisture 45 per cent.

Fermentation: Fine bulk 3¾ hours, coarse bulk 4½ hours.

Samples C and C1.

Conditions the same as A and A1, with the following alterations:

Withered 24 hours.

Loss of moisture 45 per cent.

Fermentation: Fine bulk 3¾ hours, coarse bulk 4½ hours.

Samples D and D1.

Conditions the same as A and A1, with the following alterations:

Withered 24½ hours.

Loss of moisture, 47 per cent.

Fermentation: Fine bulk 3¾ hours, coarse bulk 4½ hours.

Remarks.

(*a*) Wither is uncontrolled and depends on weather conditions. Conditions when wither was on can be described as fairly good for the season of the year.

(*b*) The speed of the rollers averaged 54 revs. per minute.

(*c*) The teas were sifted over a Michie sifter.

Commercial Value

(*a*) *Brokers.*

" All these teas are very well made and sorted. The Broken Orange Pekoes are stylish, with a very fair show of bright coloured tip, and the Broken Pekoe Souchongs are neat, well made and true to type.

" The liquors have useful colour and strength, and are quite bright. The infused leaf is rather greenish and not bright enough.

"Of the four sets in leaf the Broken Orange Pekoe A and Broken Orange Pekoe B are the best, having most tip; D being the worst. The Broken Pekoe Souchongs are all very similar. In liquor, however, the C and C1 samples are the most useful, having better colour than the others, and are also brighter. The D and D1 samples are next best, A and A1 third and B and B1 the worst."

The brokers assigned the following values to the samples:

		Per lb
A.	Broken Orange Pekoe	1s. 5d.
B.	Broken Orange Pekoe	1s. 5d
C.	Broken Orange Pekoe	1s 4d
D.	Broken Orange Pekoe	1s 3d
A1.	Broken Pekoe Souchong	10d
B1.	Broken Pekoe Souchong	10d.
C1.	Broken Pekoe Souchong	10¼d.
D1.	Broken Pekoe Souchong	10d.—10¼d.

(*b*) *Importers.*

	Value Per lb.
Sample A. Well made, bright tip, but background rather black, good coppery infusion, coloury liquor, but no flavour	1s. 4d.
Sample B Rather more tip than A Slightly inferior, but still even infusion Little less colour	1s. 4d.
Sample C. Less tip than A or B Infusion less bright	1s. 2d.
Sample D. Less tip than C, and the dullest infusion, but still fairly bright and even	1s. 1d
Sample A1. Well made, even black leaf, fairly even infusion Plain liquor with little colour	10¼d.
Sample B1 Well made, even black leaf Infusion has some dull infused leaf showing	10d–10¼d.
Sample C1. Slightly less even leaf, infusion and liquor a little duller	10d.
Sample D1. Leaf rather more ragged, and the dullest infusion and liquor	9¾d

Analytical Results

In all, forty-six of the samples received were submitted to chemical examination. These comprised all the samples from estates X, A, B, C, D, E, F/R, F/L, G, H and I; the later samples were not analysed. The results in the case of those from the first five estates mentioned have been published in the previous reports in this Bulletin, but for convenience of reference they are included with the others in Table I, which also gives the valuations for the teas. The results classified according to estates, jats and grades are shown in Tables II, III and IV.

TABLE I

COMPLETE ANALYTICAL RESULTS

Estate.	Description.	Composition (expressed on moisture-free tea).								Valuation in pence per lb.		Date of valuation.
		Moisture	Caffeine	Tannin.	Hot-water extract	Total ash	Soluble ash	Insoluble ash (less silica).	Silica.	(*a*) Brokers.	(*b*) Importers.	
		Per cent.	*Per cent.*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent.*			
X	Indian B O P. . .	7·7	4·53	12·0	51·9	5·31	3·57	1·54	0·20	9½–10	—	May 19, 1931
	Local B.O.P. . . .	7·9	3·99	15·7	50·8	5·39	3·81	1·32	0·26	14	—	
	Mixed I. + L B O P. .	7·4	4·42	14·9	49·0	5·15	3·56	1·56	0·03	8–9	—	
A	Indian O P. . . .	9·3	4·02	13·3	49·2	6·00	4·29	1·54	0·17	7½	8	(*a*) June 9, 1932
	Local O.P. . . .	9·2	3·32	11·2	48·0	6·26	4·67	1·42	0·17	7¼–8	8	(*b*) June 10, 1932
	Indian B O P. . .	8·5	4·24	14·9	50·1	5·94	4·14	1·54	0·26	6	6½	
	Local B O.P. . . .	8·5	4·44	14·5	48·5	5·32	3·71	1·40	0·21	6½	7	
	Local F.B.O.P. . .	8·5	4·19	13·5	49·6	5·45	3·74	1·47	0·24	14	18	
	Local B.P. . . .	8·5	3·39	12·8	47·7	5·62	3·78	1·67	0·17	6	6¼	
	Local P. . . .	8·3	3·85	13·3	47·2	5·44	3·59	1·65	0·20	5¾	6	
B	(1)	8·4	3·71	11·6	47·1	5·59	3·70	1·63	0·26	6–6¼	6	
	(2)	8·3	3·18	11·1	46·1	5·69	3·61	1·74	0·34	6–6¼	5¾	
C	Local	9·4	3·57	12·3	46·1	5·72	3·82	1·60	0·30	6½	6½	
D	Local B.O.P. . . .	8·3	4·22	15·8	51·2	5·78	3·93	1·54	0·31	16–17	20–22	July 29, 1932
	Local B.P.S . . .	8·5	4·01	14·8	48·9	5·22	3·62	1·44	0·16	6¼	6½	
	Indian B.O P. . .	8·7	4·45	16·2	53·2	5·65	3·94	1·45	0·26	12–13	12–14	
	Indian B.P.S. . . .	8·7	4·38	15·4	52·1	5·43	3·76	1·52	0·15	6½	6¼	
	Mixed L. + I. B.O.P. .	8·5	4·33	16·3	52·9	5·56	3·62	1·59	0·35	14–15	16	
	Mixed L. + I. B.P.S. .	8·6	4·06	14·4	52·1	5·67	3·92	1·60	0·15	6¼–6½	6½	

E	Local O.P. . . .	8·1	3·54	7·3	44·2	5·68	3·55	2·05	0·08	6¾–7	—	Jan. 23, 1933
	Local B.P. . . .	7·9	3·91	6·7	48·3	5·57	3·38	2·03	0·16	7	—	
	Local B.O.P. . . .	7·8	3·50	7·0	48·5	5·56	3·49	1·97	0·10	6¼	—	
	Local B.P.S. . . .	8·0	3·93	8·0	46·3	5·36	3·16	2·04	0·16	6½	—	
F/R	P.	6·7	3·90	9·3	47·5	5·18	3·49	1·63	0·06	8	8	(*a*) May 11, 1933
	B.P.	7·1	3·88	10·2	48·9	5·29	3·57	1·67	0·05	7¾–8	8	(*b*) May 15, 1933
	O.P.	7·6	3·27	9·3	49·5	5·48	3·57	1·88	0·03	7¼–8	8¼	
	B.O.P.	6·6	4·26	10·5	49·7	5·55	3·70	1·68	0·17	8½–9	8½	
F/L	B.P.	9·0	3·73	9·9	50·8	5·14	3·29	1·82	0·03	8–8¼	7¾	
	O.P.	8·8	3·67	11·1	52·7	5·32	3·18	2·14	0·00	8	8	
	B.O.P.	8·6	4·39	12·4	52·8	4·79	3·18	1·54	0·07	8½	8¾	
G	Indian B.O.P. . .	8·0	5·13	13·7	51·5	5·01	3·54	1·40	0·07	12	10	
	Indian B.P. . . .	6·5	4·49	12·5	48·5	5·40	3·61	1·74	0·05	8–8¼	7¾–8	
	Local B.O.P. . . .	7·9	4·64	10·2	48·7	5·00	3·60	1·37	0·03	18–20	11½	
	Local B.P. . . .	7·3	4·15	12·1	46·7	5·26	3·66	1·58	0·02	8¼	8	
	Mixed I. + L. B.O.P. .	7·6	4·86	13·2	50·2	4·99	3·58	1·40	0·01	15–16	10¾–11	
	Mixed I. + L. B.P. .	6·1	4·22	13·1	47·1	5·05	3·47	1·53	0·05	8–8¼	7¾–8	
	Blended. Mixed jats and grades . . .	6·7	3·88	11·0	46·7	5·37	3·62	1·74	0·01	8–8¼	8¼	
H	Local F.B.O.P. . .	7·6	4·51	11·3	50·2	5·61	3·55	1·71	0·35	8½	8¼	
	Local B.O.P. . . .	7·8	4·06	8·9	48·4	5·72	3·69	1·89	0·14	7¾	8–8¼	
	Local P.	7·9	4·20	11·0	47·9	5·19	3·12	1·86	0·21	8	7¾	
	Local B.P	8·0	3·89	8·6	47·1	5·85	3·80	1·96	0·09	7¾–8	7¾–8	
	Indian B.O.P. . .	7·9	4·58	11·2	49·5	5·78	3·90	1·78	0·10	8	8–8¼	
	Indian P. . . .	7·9	4·27	11·0	46·1	5·50	3·58	1·81	0·11	7¾–8	8	
	Indian B.P. . . .	8·2	4·04	9·2	47·6	5·84	3·81	1·95	0·08	7¾–8	7¾–8	
I	B.O P.	8·8	4·53	11·6	47·4	5·84	3·78	1·81	0·25	8½	8	
	P.	8·5	3·86	12·2	46·7	5·75	3·71	1·97	0·07	7¾–8	7½	

TABLE II

SUMMARY OF ANALYTICAL RESULTS, ACCORDING TO ESTATE AND JAT

Estate.	Jat.	Number of samples	Composition of moisture-free tea.														
			Caffeine			Tannin			Hot-water extract.			Total ash			Soluble ash.		
			Min *Per cent*	*Max* *Per cent*	*Mean* *Per cent*	*Min* *Per cent*	*Max* *Per cent*	*Mean* *Per cent*	*Min* *Per cent*	*Max* *Per cent.*	*Mean* *Per cent*	*Min* *Per cent*	*Max* *Per cent.*	*Mean* *Per cent*	*Min* *Per cent*	*Max* *Per cent*	*Mean* *Per cent.*
X, D, I .	Indian Local Mixed I. + L. Not stated All samples	3 3 3 2 11	4·38 3·99 4·06 3·86 3·86	4·53 4·22 4·42 4·53 4·53	4·45 4·07 4·27 4·19 4·25	12·0 14·8 14·4 11·6 11·6	16·2 15·8 16·3 12·2 16·3	14·5 15·4 15·2 11·9 14·5	51·9 48·9 49·0 46·7 46·7	53·2 51·2 52·9 47·4 53·2	52·4 50·3 51·3 47·0 50·6	5·31 5·22 5·15 5·75 5·15	5·65 5·78 5·67 5·84 5·84	5·46 5·46 5·46 5·79 5·52	3·57 3·62 3·56 3·71 3·56	3·94 3·93 3·92 3·78 3·94	3·76 3·79 3·70 3·74 3·75
A, H .	Indian Local All samples	5 9 14	4·02 3·32 3·32	4·58 4·51 4·58	4·23 3·98 4·07	9·2 8·6 8·6	14·9 14·5 14·9	11·9 11·7 11·8	46·1 47·1 46·1	50·1 50·2 50·2	48·5 48·3 48·4	5·50 5·19 5·19	6·00 6·26 6·26	5·81 5·61 5·68	3·58 3·12 3·12	4·29 4·67 4·67	3·94 3·74 3·81
G . .	Indian Local Mixed I. + L. Blended I. + L. All samples	2 2 2 1 7	4·49 4·15 4·22 — 3·88	5·13 4·64 4·86 — 5·13	4·81 4·40 4·54 3·88 4·48	12·5 10·2 13·1 — 10·2	13·7 12·1 13·2 — 13·7	13·1 11·2 13·2 11·0 12·3	48·5 46·7 17·1 — 46·7	51·5 48·7 50·2 — 51·5	50·0 47·7 48·7 46·7 48·5	5·01 5·00 4·99 — 4·99	5·40 5·26 5·05 — 5·40	5·20 5·13 5·02 5·37 5·15	3·54 3·60 3·47 — 3·47	3·61 3·66 3·58 — 3·66	3·58 3·63 3·53 3·62 3·58
E . .	Local	4	3·50	3·93	3·72	6·7	8·0	7·3	44·2	48·5	46·8	5·36	5·68	5·54	3·16	3·55	3·39
F/R. .	Not stated	6	3·18	4·26	3·70	9·3	11·6	10·3	46·1	49·7	48·1	5·18	5·69	5·46	3·49	3·70	3·61
F/L. .	Not stated	3	3·67	4·39	3·93	9·9	12·4	11·1	50·8	52·8	52·1	4·79	5·32	5·08	3·18	3·29	3·22
C . .	Local	1	—	—	3·57	—	—	12·3	—	—	46·1	—	—	5·72	—	—	3·82
All Estates	Indian Local Mixed I. + L. Not stated Blended I. + L. All samples	10 19 5 11 1 46	4·02 3·32 4·06 3·18 — 3·18	5·13 4·64 4·86 4·53 — 5·13	4·41 3·96 4·38 3·85 3·88 4·08	9·2 6·7 13·1 9·3 — 6·7	16·2 15·8 16·3 12·4 — 16·3	12·9 11·3 14·4 10·8 11·0 11·9	46·1 44·2 47·1 46·1 — 44·2	53·2 51·2 52·9 52·8 — 53·2	50·0 48·1 50·3 49·0 46·7 48·9	5·01 5·00 4·99 4·79 — 4·79	6·00 6·26 5·67 5·84 — 6·26	5·59 5·53 5·28 5·42 5·37 5·48	3·54 3·12 3·47 3·18 — 3·12	4·29 4·67 3·92 3·78 — 4·67	3·81 3·67 3·63 3·53 3·62 3·66

TABLE III

Analytical Results of B.O.P. Teas

Estate.	Jat.	Sort.	Composition of moisture-free tea			Valuations Pence per lb.	
			Caffeine	Tannin	Hot-water extract.	(*a*)	(*b*)
			Per cent.	*Per cent.*	*Per cent.*		
(1) *Teas valued at over 9d per lb.*							
X .	Indian	B.O.P	4·53	12·0	51·9	9½–10	—
	Local	B.O.P.	3·99	15·7	50·8	14	—
A .	Local	F.B.O.P	4·19	13·5	49·6	14	18
D .	Local	B.O.P.	4·22	15·8	51·2	16–17	20–22
	Indian	B.O.P.	4·45	16·2	53·2	12–13	12–14
	Mixed	B.O.P	4·33	10·3	52·9	14–15	16
G .	Indian	B.O.P.	5·13	13·7	51·5	12	10
	Local	B.O.P.	4·64	10·2	48·7	18–20	11½
	Mixed	B.O.P	4·80	13·2	50·2	15–16	10¾–11
		Mean	4·48	14·1	51·1	—	—
(2) *Teas valued at 9d or under per lb*							
X .	Mixed	B.O.P.	4·42	14·9	49·0	8–9	—
A .	Indian	B.O.P	4·24	14·9	50·1	6	6½
	Local	B.O.P	4·44	14·5	48·5	6½	7
E .	Local	B.O.P.	3·50	7·0	48·5	6¾	—
F/R	Not stated	B.O.P	4·26	10·5	49·7	8½–9	8½
F/L	Not stated	B.O.P.	4·30	12·4	52·8	8½	8¾
H .	Local	F.B.O.P	4·51	11·3	50·2	8½	8¼
	Local	B.O.P	4·00	8·9	48·4	7¾	8–8¼
	Indian	B.O.P	4·58	11·2	49·5	8	8–8¼
I .	Not stated	B.O.P.	4·53	11·6	47·4	8½	8
		Mean	4·29	11·7	49·4	—	—
		Mean omitting E[1]	4·38	12·2	49·5	—	—

[1] *The figures for Estate E stand out as exceptionally low for Nyasaland teas.*

Remarks on Analytical Figures

(1) The results show that, on the whole, teas of the Indian jat contain more caffeine, tannin and extractive matter than teas of the local jat (*see* Table II).

(2) Estate XDI gives higher figures for the average of all teas than any other estate, with Estate G as second highest (*see* Table II).

(3) Of the forty-six teas which were analysed, all those valued above 9*d*. per lb. are Broken Orange Pekoes. Some of the B.O.P.'s, however, are priced below 9*d*. (*see* Table III).

TABLE IV

SUMMARY OF ANALYTICAL RESULTS ACCORDING TO GRADE

	No of samples	All estates.									No of samples	All estates, except E 2.								
		Caffeine.			Tannin.			Hot-water extract				Caffeine.			Tannin.			Hot-water extract.		
		Min Per cent	*Max Per cent*	*Mean Per cent*	*Min Per cent*	*Max Per cent*	*Mean Per cent*	*Min. Per cent*	*Max Per cent*	*Mean Per cent*		*Min. Per cent.*	*Max Per cent.*	*Mean Per cent.*	*Min Per cent.*	*Max. Per cent.*	*Mean Per cent*	*Min Per cent*	*Max. Per cent.*	*Mean Per cent.*
B.O P. (including F.B.O P.) . .	19	3·50	5·13	4·38	7·0	16·3	12·8	47·4	53·2	50·2	18	3·99	5·13	4·43	8·9	16·3	13·2	47·4	53·2	50·3
Including :																				
B.O.P. Indian[1] .	5	4·24	5·13	4·59	11·2	16·2	13·6	49·5	53·2	51·2	—	—	—	—	—	—	—	—	—	—
B.O.P. Local[1] .	8	3·50	4·64	4·19	7·0	15·8	12·1	48·4	51·2	49·5	—	—	—	—	—	—	—	—	—	—
O.P.	5	3·27	4·02	3·56	7·3	13·3	10·4	44·2	52·7	48·7	4	3·27	4·02	3·57	9·3	13·3	11·2	48·0	52·7	49·9
B.P.	9	3·39	4·49	3·97	6·7	13·1	10·6	46·7	50·8	48·1	8	3·39	4·49	3·97	8·6	13·1	11·1	46·7	50·8	48·1
P.	5	3·85	4·27	4·02	9·3	13·3	11·4	46·1	47·9	47·1	5	3·85	4·27	4·02	9·3	13·3	11·4	46·1	47·9	47·1
B.P.S.	4	3·93	4·38	4·10	8·0	15·4	13·2	46·3	52·1	49·9	3	4·01	4·38	4·15	14·4	15·4	14·9	48·9	52·1	51·0

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[1] *The jat of the remaining six B O P. teas was not stated.*

[2] *The figures for Estate E stand out as exceptionally low for Nyasaland teas.*

The B.O.P.'s valued at more than 9*d.* per lb. contain on the average more caffeine, tannin and extractive matter than the B.O.P.'s valued at or less than 9*d.* (*see* Table III).

(4) The B.O.P.'s are higher in caffeine than other grades of the same jat on the same estate. The tannin figure follows this rule with a few exceptions. The extract figure follows this rule (*see* Table I).

(5) A summary of all results according to grade (*see* Table IV) shows that the mean for all B.O.P.'s of both jats, all estates, is higher in caffeine, tannin and extractive matter than for any other grade with the exception of Broken Pekoe Souchong. In the latter case it must be noted that only four samples were examined.

(6) The four samples of local jat from Estate E are very low in tannin—average 7·3 per cent.—much lower than the teas from any other estate. The next lowest is Estate F/R with an average of 10·3 for 6 samples.

All the samples from E were low-priced, the B.O.P. only fetching 6¾*d.* per lb.

(7) The B.O.P.'s of the Indian jat contain on the average more caffeine, tannin and extractive matter than B.O.P.'s of the local jat.

Mixed Jats. Consideration of all Samples Received

The mixing of pickings of different jats prior to manufacture is an important consideration on estates where both Indian and local jats are grown. In Table V a summary of the valuations for teas made from mixed jats is given together with the prices of the corresponding sort of tea from the separate jats.

The first set of samples, three in number, from Estate X, examined in May 1931, received valuations on the London market which were not favourable to the mixing of jats. Subsequently, however, the four sets of samples, consisting of twenty-six teas, examined between July 1932 and September 1933, showed conclusively that no monetary loss was involved in mixing the two jats. A study of the prices shows that in almost every case the value of the tea from the mixed jats is proportional to the value of the amounts of the two constituent jats. In one case, a B.O.P. consisting of a mixture of 25 per cent. Indian with 75 per

TABLE V

SUMMARY OF VALUATIONS RELATING TO THE MIXING OF JATS

Estate.	Jat.	Sort.	Valuation in pence per lb		Date of valuation.
			(a)	(b)	
X .	Indian	B.O.P.	9½–10	—	May 19, 1931
	Local	B.O P.	14	—	
	Mixed : 50 per cent. Indian 50 per cent. Local	B O.P.	8–9	—	
D .	Indian	B O.P	12–13	12–14	July 29, 1932
	Local	B.O.P.	16–17	20–22	
	Mixed : 50 per cent Indian 50 per cent. Local	B O P	14–15	16	
	Indian	B P.S	6½	6¼	
	Local	B P.S	6¼	6½	
	Mixed : 50 per cent Indian 50 per cent Local	B P S	6¼–6½	6½	
G .	Indian	B O P	12	10	(a) May 11, 1933 (b) May 15, 1933
	Local	B O P.	18–20	11½	
	Mixed : 50 per cent. Indian 50 per cent Local	B O P	15–16	10¾–11	
	Indian	B P.	8–8¼	7¾–8	
	Local	B.P.	8¼	8	
	Mixed : 50 per cent Indian 50 per cent. Local	B.P.	8- 8¼	7¾–8	
K .	Indian	B O P.	10	11	(a) June 22, 1933 (b) June 28, 1933
	Local	B O.P	11–12	14	
	Mixed : 50 per cent Indian 50 per cent. Local	B O P	10½	12	
	Indian	B P.	8¼	8½	
	Local	B P	8¼	8¼-8½	
	Mixed : 50 per cent. Indian 50 per cent. Local	B P	8¼	8½–8¾	
L .	Indian	B O P.	15	13	(a) Sept. 4, 1933 (b) Sept. 7, 1933
	Local	B O P	17	16	
	Mixed : 50 per cent. Indian 50 per cent. Local	B.O.P.	16	14	
	Mixed : 25 per cent Indian 75 per cent. Local	B.O.P.	17	16	
	Indian	B.P S.	10-10¼	9¾	
	Local	B.P.S	10	10¼	
	Mixed : 50 per cent. Indian 50 per cent. Local	B P S.	10¼	10	
	Mixed : 25 per cent Indian 75 per cent Local	B.P.S.	10	10–10¼	

cent. local, there is a gain in value over selling the jats separately.

General Conclusions

There is no absolute connection between composition and value. For whereas all the highest-priced teas were high in either tannin or caffeine, or both, the teas high in tannin and/or caffeine were not all high-priced.

A high tannin figure appears to be of more value than a high caffeine figure.

The B.O.P.'s of the local jat were higher-priced than B.O.P.'s of the Indian jat from the same estate. The other grades of the two jats were very similar in price. The B.O.P.'s of the Indian jat were nevertheless on the average higher in caffeine, tannin and extractive matter than those of the local jat.

With regard to the mixing of jats prior to manufacture, the results clearly show that the return on teas manufactured from mixed jats is equal to that from the jats sold separately.

ARTEMISIA PLANTS FROM THE COASTS OF ENGLAND AND WALES

THIS investigation of the amount of santonin present in sample populations of *Artemisia maritima* and *A. gallica* from different parts of the British coasts was undertaken by the Imperial Institute at the request of the Director of the Royal Botanic Gardens, Kew, with a view to finding a strain sufficiently high-yielding for commercial use.

The arrangements for procuring the samples were made by the Director of Kew, and it was specified that the material should be collected at the stage when the flower-buds had formed but had not opened. The botanical identity of the samples was also determined at Kew.

Results of Examination

The samples, which ranged in weight from 4 oz. to 6 lb., consisted of the aerial portions of the plants with occasional attached roots. The material taken for analysis consisted of the " strippings " from the air-dried plants and was composed of the fine shoots, leaves and flower-heads.

TABLE I

Sample No.	Locality and sender.	Ecological situation, as described by sender	Condition of buds	Identity.	Santonin, expressed on the moisture-free material.
					Per cent.
1	Snettisham, Norfolk (Dr Turrill)	Salt-marsh flooded only at high spring tides	Unexpanded	*A maritima*	1·3
2	Heacham, Norfolk (Dr. Turrill)	Old salt-marsh now drying up through artificial drainage	Do.	Do.	0·3
3	Walberswick, Suffolk (Mr. Airy Shaw)	Sand dunes near mouth of R Blyth, south bank, between ferry and sea	Do.	Do.	0·2
4	Do.	Mud flats on seaward (E) side of small creek running into R. Blyth between ferry and sea, near footbridge over creek	Do.	Do.	0·8
5	Combwich, Somerset (Mr. H. S. Thompson)	West bank of tidal R Parrett, among grass and some stones of embankment	Do.	Do.	trace
6	Do.	Between stones of wall on west bank of tidal R Parrett	Do.	Do.	0·2
7	Do.	Muddy soil recently inundated by tide West bank of tidal R Parrett	Do.	Do.	0·2
8	Do.	West bank of tidal R Parrett, under direct influence of high tides	Do.	Do.	trace
9	Bradwell-on-Sea, Essex (Mr. J. Bryce)	Just on and just above spring-tide high-water mark, growing between stones covering face of sea-wall	Do.	Do.	0·9
10	Hadleigh, Essex (Mr. J. Bryce)	Just on or just above high-water mark of spring-tides, growing between stones of sea wall. Periodically wetted by sea-water	Do.	Do.	0·6
11	Do.	Do.	Do.	Do.	0·4
12	Bradwell-on-Sea, Essex (Mr. J. Bryce)	Just on and just above spring-tide high-water mark, growing between stones covering face of sea-wall	Do.	Young plants: approaching *A. gallica*	Some, but less than 0·2
13	Wakering, Essex (Mr. J. Bryce)	Just above high-water mark of spring tides, in clay of sea-wall	Do.	*A maritima*	0·2

14	Do.	Half-way up landward face of sea-wall, growing in the clay, amongst *Agropyron* Seldom if ever in contact with sea-water	Do.	Do.	Some, but less than 0·2
15	Portbury Flats, Somerset (Mrs. C. Sandwith)	Slope of bank above tide level in rather dry condition	Partially expanded	Do	0·3
16	Do.	At tide level, growing on mud amongst stones washed by high tides	Do.	Do.	0·3
17	E. Aberthaw, Glamorgan (Miss E. Vachell)	Near railway and not very liable to tidal inundation	Unexpanded	*A. gallica*	0·8
18	Do.	Near stream, but not likely to be inundated	Mainly unexpanded. Some slightly expanded	*A. maritima*	0·5
19	E. Aberthaw, Glamorgan (Miss E. Vachell)	Near stream, and " most often inundated by tidal water " of the four samples	Slightly expanded	*A. gallica*	0·5
20	Do.	Similar to preceding sample (No. 19) but growing a few feet higher	Do.	*A. maritima*	0·7
21	Woodspring, Somerset (Mrs. Walker)	Bank of R Severn, occasionally inundated with tidal water	Mostly partially expanded	Do.	0·4
22	Cleethorpes, Lincs. (Mr. A. Bullock)	Foreshore at Humberstone, near Cleethorpes Washed by sea-water and spray during high tides	Do.	Do.	0·3
23	Newhaven, Sussex (Miss K. Pickard)	Rather muddy bank of tidal R. Ouse at Southease Bridge, near Newhaven	Unexpanded	(*a*) *A. gallica* (*b*) Probably *A. gallica* or an intermediate with *A. maritima*	Some, but less than 0·2 per cent. in each case
24	Sunk Island, E. Yorks. (Mr. W. L. Waugh)	Bank of irrigation dyke some 100 yards from R. Humber shore. Inundation from dyke water unlikely	Do.	*A. gallica*	0·3
25	Do.	On chalk scree in salt-marsh Soil covered to several inches at extra high tides About 20 yards from ordinary high-tide mark	Do.	*A. maritima*	0·3
26	Kilnsea, E. Yorks. (Mr. W. L. Waugh)	Side of dyke about ¼ mile from R. Humber. Roots probably submerged in very wet periods	Do.	Probably *A. gallica*, but too young for exact determination	Some, but less than 0·2

Previous investigations of Artemisia plants have shown that the main woody stem and roots are free from santonin.

In several instances the senders of the material also supplied samples of " heads " which had been separately collected. These consisted of fine shoots, leaves and buds and were in most cases too small for analysis. They were, however, very similar in character to the " strippings " of the whole plants which were employed for the santonin determinations.

Table I shown on pages 34–35 gives the locality of origin and name of sender, the ecological situation, the condition of the flower-heads, the botanical identity, and the amount of santonin in each sample, as determined by Nelson's modification of the Katz-Fromme method (*Journ. Assoc. Off. Agric. Chem.* 1916, **2**, 80).

The results of the examination show that the amount of santonin present in the " strippings " varied from a

TABLE II

SAMPLES CONTAINING MOST SANTONIN

Sample No.	Locality.	Identity	Ecological situation.	Santonin
				Per cent
1	Snettisham, Norfolk	*A maritima*	Salt-marsh flooded only at high spring tides	1·3
9	Bradwell-on-Sea, Essex	Do.	Just on and just above spring-tide high-water mark, growing between stones covering face of sea-wall	0·9
4	Walberswick, Suffolk	Do.	Mud flats on seaward (E) side of small creek running into R Blyth between ferry and sea, near footbridge over creek	0·8
17	E. Aberthaw, Glamorgan	*A. gallica*	Near railway and not very liable to tidal inundation	0·8
20	Do.	*A. maritima*	Similar to No. 19 (see below) but growing a few feet higher	0·7
10	Hadleigh, Essex	Do.	Just on or just above high-water mark of spring tides, growing between stones of sea-wall. Periodically wetted by sea-water	0·6
18	E. Aberthaw, Glamorgan	Do.	Near stream, but not liable to be inundated	0·5
19	Do.	*A. gallica*	Near stream and " most often inundated by tidal water " of the four samples from this locality	0·5

TABLE III

SAMPLES CONTAINING LEAST SANTONIN

Sample. No.	Locality	Identity.	Ecological situation.	Santonin. *Per cent.*
12	Bradwell-on-Sea, Essex	Young plants, approaching *A. gallica*	Just on or just above spring-tide high-water mark, growing between stones covering face of sea-wall	Some, but less than 0·2
14	Wakering, Essex	*A. maritima*	Half-way up landward face of sea-wall, growing in the clay, amongst *Agropyron*. Seldom if ever in contact with sea-water	Do.
23A	Newhaven, Sussex	*A. gallica*	Rather muddy bank of tidal R. Ouse at Southease Bridge, near Newhaven	Some, but less than 0·2 per cent. in each case
23B	Do.	Probably *A. gallica* or an intermediate with *A. maritima*	Do	
26	Kilnsea, E. Yorks	Probably *A. gallica*, but too young for exact determination	Side of dyke about ¼ mile from R Humber Roots probably submerged in very wet periods	Some, but less than 0·2
5	Combwich, Somerset	*A. maritima*	West bank of tidal R. Parrett, among grass and some stones of embankment	trace
8	Do.	Do.	West bank of tidal R. Parrett, under direct influence of high tides	trace

trace to 1·3 per cent. Eight samples contained 0·5 per cent. or over, twelve samples 0·2 to 0·4 per cent. and seven samples less than 0·2 per cent.

For convenience of reference particulars of the eight samples containing the most santonin and of the seven containing the least have been brought together as shown in Tables II and III.

Remarks

The number of samples examined is not sufficient to enable definite conclusions to be drawn as to the effect on the santonin content of the species of plant, the geographical origin and the ecological situation, but the following general observations may be offered.

Species of Plant.—Of the twenty-seven samples, twenty consisted of *A. maritima*; six of these contained 0·5 per cent. or over of santonin, the maximum figure (1·3 per cent.) being given by the sample from Snettisham, Norfolk; eleven contained from 0·2 to 0·5 per cent.; and three less than 0·2 per cent.

The amounts of santonin present in the other seven samples, representing *A. gallica*, ranged from less than 0·2 per cent. to 0·8 per cent.; two of the samples contained 0·5 per cent. or over and four of them less than 0·2 per cent.

In three cases, samples of both *A. maritima* and *A. gallica* were received from the same area, viz. E. Aberthaw, E. Yorks. (Sunk Island), and Bradwell-on-Sea. The samples from E. Aberthaw (Nos. 17–20) contained similar amounts of santonin irrespective of the species, as also did the samples from Sunk Island (Nos. 24 and 25); on the other hand the *A. maritima* from Bradwell-on-Sea (No. 9) contained 0·9 per cent. of santonin whereas the *A. gallica* (No. 12: young plants, approaching *A. gallica*) contained less than 0·2 per cent.

Geographical Origin.—The ten samples from East Anglia (Norfolk 2, Suffolk 2 and Essex 6) show considerable variation in santonin content, from less than 0·2 to 1·3 per cent. It is noteworthy that one sample from each county is included in the four highest results. With one exception all the samples were *A. maritima*; the *A. gallica* sample was one of the lowest of the whole series in santonin.

The single sample from Lincolnshire (Cleethorpes) and the three from East Yorkshire (Sunk Island and Kilnsea) were all low in santonin; three of them, two *A. maritima* and one *A. gallica*, contained 0·3 per cent. and the other, probably *A. gallica*, less than 0·2 per cent.

The material from Sussex (Newhaven) was a mixture of (1) *A. gallica*, and (2) probably *A. gallica*, or an intermediate with *A. maritima*. Both contained less than 0·2 per cent. of santonin.

The seven samples from Somerset (all *A. maritima*) were also low in santonin, ranging from a trace to 0·4 per cent. The samples from Combwich were inferior to those from Portbury Flats and Woodspring.

The four samples from Glamorgan (E. Aberthaw) are noteworthy in that they each contained 0·5 per cent. or more of santonin, the range being 0·5 to 0·8 per cent. The two *A. gallica* samples gave equally good results as the two *A. maritima*.

Ecological Situation.—It has been suggested that Artemisia plants which are periodically covered by the tide or sprayed with sea-water may be high-yielding strains and the collectors were asked to pay special attention to such habitats. The results of the santonin determinations, however, do not permit of definite conclusions on this point.

Reference to Table II shows that the three samples of *A. maritima* (Nos. 1, 9 and 4) containing the highest percentages of santonin (1·3, 0·9 and 0·8 per cent. respectively) were growing in situations which all appear liable to salt-water flooding at intervals. On the other hand some of the samples of *A. maritima* (e.g. Nos. 11, 13, 16 and 22) growing under similar conditions of exposure to sea-water in other localities contained only from 0·2 to 0·4 per cent. of santonin.

The sample of *A. gallica* (No. 17) which contained most santonin (0·3 per cent.) was from a situation "not very liable to tidal inundation." Three other samples of this species (Nos. 12, 23A and 23B) which each contained less than 0·2 per cent. of santonin were growing in one case on the face of the sea-wall just on and just above spring-tide high-water mark and in the other two cases on the muddy bank of a tidal river.

The two samples of *A. maritima* from the adjoining areas of Snettisham and Heacham in Norfolk (Nos. 1 and 2) afford an interesting comparison: the sample from Snettisham growing on a salt marsh flooded only at high spring tides contained 1·3 per cent. of santonin; that from Heacham, growing on an old salt-marsh now drying up through artificial drainage, contained only 0·3 per cent. The Heacham plants, therefore, were exposed to less saline conditions than those from Snettisham.

In the case of the two samples of *A. maritima* from Walberswick, Suffolk (Nos. 3 and 4), the one which was growing on mud flats on the side of a small creek running into the R. Blyth contained more santonin than the other sample growing on the sand dunes.

The two samples from Bradwell-on-Sea (Nos. 9 and 12) give a comparison of *A. maritima* and of young plants approaching *A. gallica* growing under identical conditions: "just on or just over high-water mark of spring tides, growing between stones of sea-wall; periodically wetted by the sea." The *A. maritima* No. 9 contained a relatively high percentage of santonin, whilst No. 12, approaching *A. gallica*, contained less than 0·2 per cent.

General.—The results of previous examinations of *A. maritima* and *A. gallica* by different investigators agree with those obtained in the present enquiry in showing wide variations in the amount of santonin present. It is also known that *A. Cina* and the form of *A. maritima* known as *A. brevifolia*, which are used as commercial sources of santonin, exhibit similar differences even in the case of plants growing in adjacent areas.

The amount of santonin in commercial santonica from *A. Cina* varies from about 2 to 3 per cent. In the case of the Indian *A. maritima* (*A. brevifolia*), a yield of over 2 per cent. of santonin has also been obtained. The quantity present in samples of the latter plant examined at the Imperial Institute some years ago ranged from 0·79 to 1·79 per cent. (see this BULLETIN, 1923, **21,** 316), whilst a further sample from Kashmir examined this year contained 1·23 per cent. The results obtained by Krishna and Varma for material from the Kurram Valley, North-West Frontier Province, show similar figures (*Quarterly Journal of Pharmacy*, 1933, **6,** 23).

The minimum amount that is worth extracting on a commercial scale depends on a number of factors, among the chief of which is the price of the ordinary commercial supplies of santonin. It is stated in the Imperial Institute report referred to above (*l.c.*, p. 318) that at the high prices then obtaining manufacturers considered that it would be remunerative to extract santonin from material containing as little as 0·9 per cent. More recently the opinion has been expressed that about 1·2 per cent. is the lowest that would be worth working. On the latter basis only one of the present samples, viz. that from Snettisham (No. 1), containing 1·3 per cent. of santonin, could be considered as commercially exploitable, whilst only one other sample

(No. 9, from Bradwell-on-Sea) falls within the limits of the lower figure of 0·9 per cent.

During the course of this investigation it was ascertained that Dr. James Coutts had carried out an investigation of the santonin content of Artemisia plants from localities in England, Wales and Scotland. A summary of his results, which Dr. Coutts has kindly communicated to the Imperial Institute, shows points of much interest in connection with the foregoing report. Dr. Coutts proposes to publish a paper on the subject shortly, and it is hoped to give an account of his work in a further issue of this BULLETIN.

ARTICLES

THE DRYING OF EAST AFRICAN HIDES WITH REFERENCE TO THE PREVENTION OF BLISTER

IN 1930 the attention of the Imperial Institute Advisory Committee on Hides and Skins was drawn to the subject of " blister " in East African hides by the late Mr. Eustace Montgomery, Adviser on Animal Health to the Secretary of State for the Colonies, who was a member of the Institute's Advisory Council on Plant and Animal Products, and also of the Hides and Skins Committee. The occurrence of blister in Mombasa hides is a serious defect which, it is stated, may result in a loss of up to 25 per cent. of the hides in the tanning process. The possibility of this loss naturally affects the price offered for the hides, and their value would be enhanced if the defect could be substantially reduced or eliminated.

A comprehensive scheme for investigating the causes of blister, drawn up by Mr. Montgomery and approved by the United Tanners' Federation, was adopted by the Committee, and transmitted to the Secretary of State for the Colonies, with a recommendation that the investigation should be undertaken in Kenya. The proposal was approved, and in 1932 the Government of Kenya authorised the experiments.

The scheme involved the special preparation of 1,000 hides for detailed examination in this country. Arrangements were made for the inspection of the raw hides by merchants and brokers in London and Liverpool; for tanning trials; and for the examination of the resulting leather by technical experts.

The reports received from all these sources were brought before the Committee on Hides and Skins, who appointed the following Sub-Committee to consider a draft report prepared by the Secretary:

Dr. Dorothy Jordan Lloyd (Director, British Leather Manufacturers' Research Association), *Chairman.*
R. Withinshaw (The Penketh Tanning Co.).
H. W. Chadwick (Messrs. Chadwick & Hollebone).
Sir David Prain (Chairman, Advisory Council on Plant and Animal Products, Imperial Institute).
Dr. J. R. Furlong (Imperial Institute), *Secretary.*

The Sub-Committee approved the report, which was subsequently adopted by the Committee, and is now printed for general information. The results show that free exposure of both sides of the hide during drying is the chief factor in preventing blister and general putrefactive damage, and a simple method of drying suitable for native use, based on this result, is described. It is believed that this method will yield dried hides almost, if not quite, equal in quality to shade-dried hides, without the trouble and expense involved in providing the bandas required for shade drying. It is recommended that the proposed method be given consideration and trial.

The report illustrates admirably the value of co-operation between producers and users in investigating problems such as that dealt with in this enquiry. The Imperial Institute is greatly indebted to the members of its Advisory Committee on Hides and Skins, to Veterinary Officers in Kenya, and to technical experts, tanners, merchants and brokers in the United Kingdom, who have all rendered invaluable assistance in connection with the investigation.

THE DRYING OF EAST AFRICAN HIDES WITH REFERENCE TO THE PREVENTION OF BLISTER

REPORT BY THE IMPERIAL INSTITUTE ADVISORY COMMITTEE ON HIDES AND SKINS

INTRODUCTION

These experiments were undertaken for the purpose of ascertaining the conditions conducive to the development of " blister " and " taint " in East African hides, and with a view to devising a method of drying which prevented the development of such damage and was capable of being followed in districts where shade drying was impracticable.

By the term " blister " is understood a condition of rottenness between the inner and outer surfaces of the hide, which is often not detectable until the hide is soaked at the commencement of tannery operations, and which results in damage that completely penetrates the leather. Putrefactive damage of a lesser degree, which affects the surface of the hide, is referred to as " taint " and may occur on the grain side or on the flesh side of the hide, and results in superficial damage to the leather.

The factors believed to influence the formation of blister and taint are delay between flaying and drying ; presence of fat left on the hide ; and irregular drying. Experience has shown that hides dried in the shade are largely free from these defects, but it is not practicable for this method, which necessitates the erection of bandas, to be used in all localities.

SCHEME OF EXPERIMENTS

The drying experiments embraced inter-related series covering both wet and dry seasons of the year ; the period elapsing between flaying and stretching the hide to dry ; freedom from fat and meat, or its presence ; drying under variously modified " shade " conditions of simple application ; and drying according to native practice for comparison of the results.

The experiments were conducted by the Division of Animal Industry, Kenya, on ground adjoining the Nairobi Abattoir, and were as follows :

Five hundred hides were prepared in the wet season (between May 2 and June 29, 1932), and 500 in the dry season (between October 7 and December 29, 1932).

In each season the 500 hides were divided into two lots of 250 hides each. One lot of 250 hides was left for one hour after flaying, before stretching them out to dry. The other lot of 250 hides was left for a period of six hours.

Each lot of 250 hides was divided further into two series of 125 hides each. One series of 125 hides was cleaned by removing obvious pieces of fat and flesh, the other series was not cleaned. The cleaning was carried out immediately after stretching.

Each series of 125 hides was divided into five batches of 25 hides and dried by five different methods as follows:

(i) *Shade. Air Cushion.*—Dried in the shade, in banda with grass roof; stretched on pegs so as to allow a space of not less than 3 in. between ground and sides of hide, the ridge of the hide, head to tail, being supported on a pole, erected about 9 in. high, the hump being raised and loosely stretched by insertion of pieces of light wood.

(ii) *Sun. Air Cushion.*—Dried in sun, stretched on pegs off the ground in the same manner as that described in (i).

(iii) *Sun. Grass Cushion.*—Dried in sun, stretched on a bed of dry grass about 2 in. thick.

(iv) *Sun. Ground.*—Dried in sun, stretched directly on the ground as usually practised.

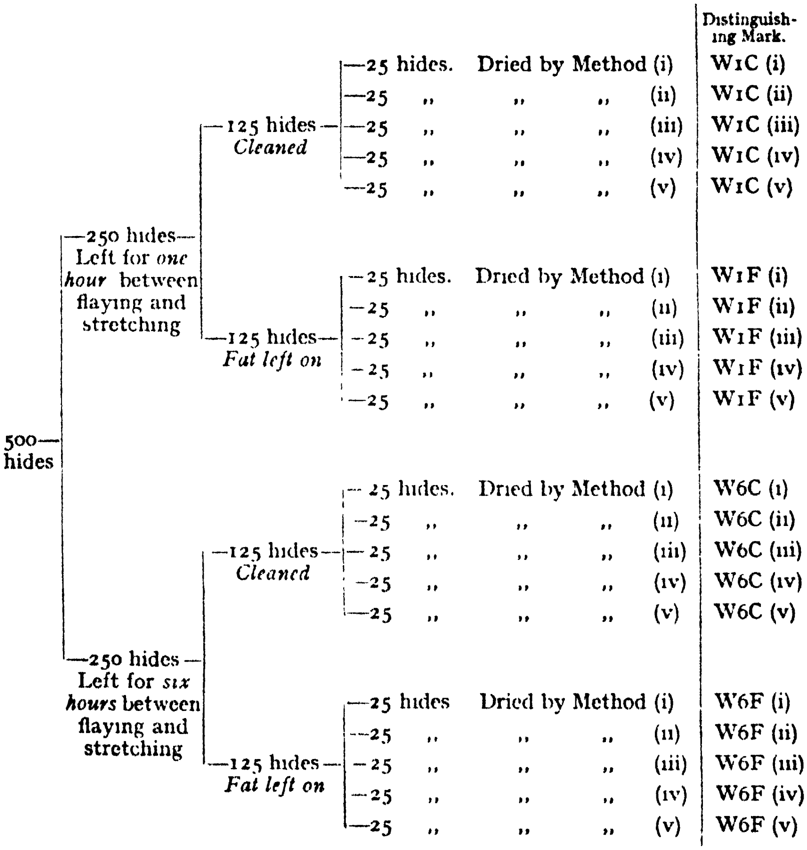
(v) *Sun. Grass Cover.*—Dried in sun, stretched directly on the ground, but flesh side loosely covered with grass, either green or dry, between 7 a.m. and 5 p.m.; the covering being removed during the night and when cloudy.

In all experiments the hides were stretched with flesh side uppermost.

The marks employed to distinguish the experiments are as follows:

W = Wet season.
D = Dry season.
1 or 6 = Hours delay between flaying and stretching.
C = All obvious gross pieces of adherent fat or loosely attached flesh removed immediately after stretching.
F = Excessive fat or flesh not removed.
(i) to (v) = Methods of drying.

The following plan expresses graphically the scheme of experiments in the wet season, and gives the marks by which the final batches of hides were distinguished. The same scheme was employed in the dry season, and the batches were marked with D instead of W :



					Distinguishing Mark.
500—hides	—250 hides— Left for *one hour* between flaying and stretching	—125 hides— *Cleaned*	—25 hides.	Dried by Method (i)	W1C (i)
			—25 ,,	,, ,, (ii)	W1C (ii)
			—25 ,,	,, ,, (iii)	W1C (iii)
			—25 ,,	,, ,, (iv)	W1C (iv)
			—25 ,,	,, ,, (v)	W1C (v)
		—125 hides— *Fat left on*	—25 hides.	Dried by Method (i)	W1F (i)
			—25 ,,	,, ,, (ii)	W1F (ii)
			—25 ,,	,, ,, (iii)	W1F (iii)
			—25 ,,	,, ,, (iv)	W1F (iv)
			—25 ,,	,, ,, (v)	W1F (v)
	—250 hides— Left for *six hours* between flaying and stretching	—125 hides— *Cleaned*	—25 hides.	Dried by Method (i)	W6C (i)
			—25 ,,	,, ,, (ii)	W6C (ii)
			—25 ,,	,, ,, (iii)	W6C (iii)
			—25 ,,	,, ,, (iv)	W6C (iv)
			—25 ,,	,, ,, (v)	W6C (v)
		—125 hides— *Fat left on*	—25 hides	Dried by Method (i)	W6F (i)
			—25 ,,	,, ,, (ii)	W6F (ii)
			—25 ,,	,, ,, (iii)	W6F (iii)
			—25 ,,	,, ,, (iv)	W6F (iv)
			—25 ,,	,, ,, (v)	W6F (v)

The 500 hides prepared in the wet season were divided into two equal consignments, both of which were representative of the experiments ; one consignment was shipped to London (Imperial Institute) and one to Liverpool, where it was handled by British Tanners, Ltd. The dry-season hides were treated in a similar manner.

The wet-season hides arrived in this country in November 1932, and the dry-season hides in March 1933. Records of the experiments and meteorological data were furnished by the Kenya authorities.

OBSERVATIONS ON THE DRY HIDES

Arrangements were made for the trade and persons interested in the subject to inspect the dry hides in warehouses in London and Liverpool. Tanners and hide brokers were notified, through their official organisations.

On behalf of the Committee the dry hides as received were inspected by Sir David Prain (*Chairman*), Dr. J. R. Furlong (*Secretary*), Dr. D. Jordan Lloyd (British Leather Manufacturers' Research Association), Mr. H. W. Chadwick (Messrs. Chadwick & Hollebone), and Mr. W. L. Brown (British Tanners, Ltd.), the following being a summary of their observations :

(*a*) **Wet Season.**—The cleaned (or " shaved ") hides of Series C were generally superior as regards condition and freedom from putrefactive damage to the hides with flesh and fat left on, Series F. Although the damage, due to gouging in removing the excess fat and flesh, which will be referred to later, was noted, the severity of the injury was not apparent at this stage.

The sun-dried hides of Method (ii) were considered to be equal in appearance to the shade-dried hides of Method (i), while the hides dried by Method (iii) were regarded as only slightly inferior. The hides of Methods (iv) and (v) were distinctly inferior in condition to the foregoing, and in particular the hides of experiments W1F (v) and W6F (v) were badly putrefied and infested with worm.

(*b*) **Dry Season.**—In this consignment, which on the whole was superior to that from the wet-season experiments, the good appearance of hides dried by Methods (ii) and (iii) in comparison with the shade-dried hides of Method (i) was again noted. The hides dried by Method (v) were considerably superior to the corresponding hides of the wet season, and comparable with those of Methods (i), (ii) and (iii) of the dry season. The cleaned hides (Series C) were again considered to be of very good appearance.

No material difference in condition was observed between the hides left for a short interval between flaying and stretching and those subjected to a delay of six hours.

Attention was particularly called to the excessive branding of the hides used in both seasons.

Detailed descriptions of the dry hides are included in the tanners' reports, Appendixes Nos. I and II.

TANNING TRIALS

With the co-operation of the United Tanners' Federation arrangements had been made for the hides to be tanned, and for reports to be furnished on the working of the goods with special reference to blister and taint.

The Penketh Tanning Co. tanned all the hides (500) from the wet-season experiments, and half the output (250 hides) from the dry-season experiments, producing vegetable-tanned sole leather.

The firm's report forms Appendix No. I. It includes a description of each hide in the dry state as received, and at the pelt stage in the tannery operations. The pelt stage is reached after the liming, dehairing and fleshing has been carried out, and is the best period at which to observe the characters of the hide. General remarks on the hides and pelts of each experiment, together with various data, are given.

Messrs. W. L. Ingle, Ltd., tanned the other half of the consignment of dry-season hides (250), producing chrome-tanned box side leather to be used for boot uppers. The limed pelts were inspected at the tannery, on behalf of the Committee, by Dr. J. R. Furlong.

Messrs. Ingle's report forms Appendix No. II, and consists of a report on the dry hides as received at the tannery, and on the pelts after liming and dehairing.

EXAMINATION OF LEATHER

The leather produced by the Penketh Tanning Co. from the wet-season and dry-season hides was inspected by Dr. D. Jordan Lloyd, Director of the British Leather Manufacturers' Research Association, and by Dr. J. R. Furlong. The Report forms Appendix No. III.

Samples of leather representative of each experiment were submitted to microscopical examination by the Research Association. The results are given in Appendix No. IV.

SUMMARY OF RESULTS

Season.—The hides prepared in the dry season are much superior as regards freedom from putrefactive damage to those of the wet season. Reference to Appendix No. V (a table giving the number of days required for the drying of the hides) will show that in certain experiments in the wet season considerably longer periods of drying were necessary than in the dry season. The meteorological records of the experiments furnished by the Kenya authorities do not include rainfall ; a short summary of the recorded figures for temperature and humidity is given in Appendix No. VI, and shows that the mean humidity at noon and at 4 p.m. in the wet-season period was considerably higher than in the dry season, though the variation in temperature between the two periods was not great. It is, therefore, in accordance with anticipation that the condition of greater dampness obtaining in the wet season had caused, in many cases, slower drying than in the dry season, and was more conducive to the development of putrefaction. The difficulties of the wet season are apparent from the records of experiments W1F (v) and W6F (v), in which the notes on the condition of the hides when taken to store, read as follows : " Maggot-eaten, owing to very heavy rain—most days under water," and " Badly cured, damp state of ground." In these two experiments the times of drying were 12 and 11 days respectively, and, as the results show, the hides were badly putrefied, 37 out of a total of 50 being thrown for glue in the tannery operations.

Interval between Flaying and Stretching.—The influence on the quality of the hide due to varying this interval from one to six hours is not observable, and these experiments provide no evidence that a delay of six hours before stretching the hides to dry is productive of greater putrefactive damage than an interval of one hour.

Cleaning.—The hides which had been freed from obvious fat and flesh, Series C, are, on the whole, considerably freer from taint and blister than the hides of Series F. The removal of fat and flesh, however, has been carried out with such gouging of the hides that a greater evil has been introduced. The loss in value due to gouging in Series C is greater than the advantage which this series holds as regards taint over Series F.

The beneficial effect of removing the fat and flesh is not so marked in Methods (i) and (ii) as in the other methods of drying ; in fact, the advantage of cleaning the hides for these two methods is only slight.

Method of Drying.—The hides dried by Method (i) are the most free from blister and general putrefactive damage, while Method (ii) has yielded results only slightly inferior to those of Method (i). In Method (ii) the use of a pole to elevate the hide has in some cases given rise to taint along the line where the pole was in contact with the hair side of the hide. As this defect only occurs in some hides it may be due to the hides in question having been stretched too tightly over the pole, thereby preventing the efficient drying of that portion of the hide in contact with the pole.

The hides prepared by the first two methods are superior by a very considerable margin to those produced by Methods (iii), (iv) and (v), as reference to Appendix No. VII, a summary of the occurrence of blister and taint in the hides, will show. It must, however, be pointed out that Method (v) gave results in the dry season that are not much inferior to those of Method (ii). The hides dried in the wet season by Method (v) are, however, exceptionally poor. Even when allowance is made for two of the four batches of hides prepared by this method in that season, to which reference has already been made, viz. W1F (v) and W6F (v), the hides that suffered severely from wet ground conditions, the remaining two batches, W1C (v) and W6C (v), have yielded only very poor results.

In the wet season the results of Method (iii) are very slightly better than those of Method (iv), which are in turn better than those of Method (v). In the dry season the hides of Method (v) are superior to those of Method (iv) and these in turn are better than the hides of Method (iii).

Quality of the Leather.—The microscopical examination shows the leather from all experiments to be of good quality apart from localised damage due to blister and taint, the hides of the dry season having produced on the whole somewhat better leather than the wet-season hides. Since the quality of the leather, which was free from putrefactive damage, has not been influenced by the methods of preparation or drying, these methods may be judged with reference only to the occurrence of blister and taint in the products.

Gouging.—The hides comprising Series C in the experiments of both wet and dry seasons are, as already mentioned, badly gouged by careless application of the knife in removing fat and flesh. The opportunity is taken to direct attention to the lowering of value due to such damage. Reference to the Penketh Tanning Co.'s Report (Appendix No. I) will show the large numbers of hides of Series C which were classified as "cut" in the lime-yard selection of pelts. Pelts classified as "cut" are approximately equal in value to "fifths," and yield leather that realises only half the price it would fetch if free from gouging damage.

Branding.—Although the subject of branding is not concerned in this investigation, and the presence of brand marks has not been taken into account in considering the results of the various experiments, attention must be drawn to the extensive branding marks on the hides used in this investigation. The hides, with few exceptions, were heavily branded, in many cases over the entire length of the hide. Such brand marks seriously reduce the value of the hide. The branding present on these two consignments of experimental hides is far in excess of that on commercial consignments of ordinary Mombasas.

Weight of Hides.—The experimental data furnished by the Division of Animal Industry included the weight of each hide employed, in the wet state and after drying. From a study of these figures it was noted that the range of weights in each experiment was generally similar. The experiments are, therefore, comparable in this respect. The weights are recorded in detail in the Penketh Tanning Co.'s report, together with weighings made at the tannery.

CONCLUSIONS

It was known before these experiments were undertaken that the method whereby hides were hung up in the shade to dry gave considerably better results as regards freedom from taint and blister than the simpler native method of pegging out hides on the ground in the sun. These experiments amply confirm this fact, and the results of the various modified sun-drying methods investigated permit of deductions being drawn as to the principal factors influencing the development of the defects in question.

The outstanding result is that yielded by Method (ii), a method in which the hides are exposed to the full force of the sun, but stretched out at a short distance from the ground so as to allow free circulation of air on both sides of the hide, as distinct from the native method (iv) in which the hide is in close contact with the ground. The hides produced by Method (ii) are only slightly inferior to shade-dried hides. The hides from the other methods, in which one or both sides of the hide were subject to restricted air circulation, either through contact with the ground or a layer of grass, are all very inferior to the hides of Method (ii). It is thus clear that free exposure of both sides of the hide in drying is highly beneficial in preventing putrefaction. This is further supported by the fact that a little damage occurred in Method (ii) where the pole underneath the hide was in contact with the surface of the hide and prevented drying along that line of contact. It may thus be stated that confinement of either surface of a hide in drying is conducive to the development of blister and taint damage.

Since the hides dried in the shade by Method (i) are only slightly better than those dried in the full sun by Method (ii), it must be concluded that the provision of shade is not an important factor in the prevention of blister. The difference between the two methods consists in a roof over the hides in Method (i). This would provide shade and protection from rain, and the slight advantage in results must be attributed to these two factors, but as the hides from both methods were outstandingly superior to those from Method (iv), sun-drying on the ground, it follows that the most important factor in preventing blister is the exposure of both sides of the hide to air circulation, such as that provided in Methods (i) and (ii), while provision of shade, and protection from rain, are of less importance.

In Method (v) a light layer of grass was placed on top of the hide to temper the force of the sun's rays. In the dry season this gave results which are on the whole better than the native method, in which the upper surface is exposed, but for the wet season the results from this method are disastrous, the layer of grass obviously acting as a hindrance to drying under moist conditions. Method (v) is, therefore, not to be recommended as a general method, but the results in the dry season may be regarded as indicating that some tempering of the sun's force is beneficial. On the other hand, full exposure to the sun in Method (ii) in the dry season gave rather better results. The explanation of this apparent contradiction is that in Method (v) the hide was close to the ground and, therefore, in a hotter position than at a short distance from the ground as in Method (ii). The effect of adding a covering of grass in Method (v) was to make the position less severe.

The results for Method (iii) over the two seasons do not show this method to possess any material advantage over Method (iv), the native method now practised.

Turning to factors other than methods of drying which influence the development of blister, the results of these experiments show that the presence of excessive fat and flesh on the hide is conducive to the development of putrefactive damage. Under the conditions of drying in Methods (iii), (iv) and (v), the effect is very pronounced, but when the hide is dried by Methods (i) or (ii) the presence of fat and flesh has not such a marked influence on the development of blister and taint. It may be concluded that the covering of fat or flesh retards the drying of the hide, and the confined moisture, under the influence of the sun's heat, assists putrefactive action. When the hide is exposed to the air on both sides, as in Methods (i) and (ii), the relatively small areas of fat and flesh do not play so great a part in preventing the escape of moisture as in Methods (iii), (iv) and (v), where one or both sides of the hide are covered, either by grass or through contact with the ground. These experiments as a whole do show, however, that the removal of excessive fat lessens the risk of blister damage, but, as already mentioned, the cleaning was attended by severe gouging of the hides. The advantage to be gained by reducing blister damage by cleaning the hide would be lost by the lowering of value due to careless use of the knife, and the removal of fat and flesh, as in Series C, cannot be recommended unless considerable improvement can be effected in the use of the knife.

With regard to the delay between flaying and drying the hide, these experiments have not provided evidence that ill effects result from a delay of six hours, but on the other hand, as no advantage is apparent from such a procedure, and as it is one that is subject to suspicion, the safer method is to stretch the hide for drying as soon as possible after slaughter.

The Committee consider that Method (ii) is worthy of consideration as the basis of a simple method of drying which should be superior to the native method of drying hides in the sun on the ground, and which will be easier to follow than the shade-drying method, which necessitates the erection of bandas.

Method (ii) as carried out in these experiments was subject to a fault arising from contact of the hide with the pole employed for raising the middle of the back. It is, therefore, necessary to eliminate this fault, and, at the same time, secure the object for which the pole was employed, viz. to raise the hide in order to allow rain to run off. The improved method which the Committee propose is as follows :

Method Proposed for Drying Hides

The equipment required for this method consists of horizontal poles erected at a suitable distance from the ground (about 5 ft.) ; the poles to be in a line running east and west.

The tail butt and hind shanks of a hide are tied to the pole with ropes, while the head and fore shanks of the hide are tied with ropes to pegs in the ground. The pegs are placed on the line of the shadow thrown by the horizontal poles at midday. The hide is thus stretched at an angle with the ground, flesh side uppermost. The lower end of the hide should be attached by ropes to the pegs, but should be free of the ground. The ropes may be fixed to the poles and pegs, and used repeatedly.

It will be necessary at intervals, of perhaps a week, to move the line of the pegs to correspond with the shadow of the pole due to the sun's position, but the daily variation will not be large enough to be worth consideration.

By this method the hide will be freely exposed on both sides for drying ; any rain which falls on the hide will run off, and the hide will be exposed to the sun in such a manner that the rays fall very obliquely on it. The sun's effect will, therefore, be somewhat less than when the rays beat directly upon hides stretched out flat on the ground.

The method does not necessitate so much equipment as is required for shade drying, and should be suitable for general application in both the dry and the wet seasons.

The Committee are of the opinion that the above method of drying hides should ensure greater freedom from blister and taint than the native method now practised, and that the results will be only slightly inferior to those obtained by shade drying. The method is recommended for consideration and trial.

DEMONSTRATION SAMPLES OF LEATHER

In order to demonstrate the defects to which reference has been made in the report, the Penketh Tanning Co. have kindly provided the following bends of leather, selected from those made in this investigation at their tannery, for transmission to Kenya :

Bend.	Description.	Value per lb.
No. 1	Sound	14*d.*
No. 2	Blistered	7½*d.*
No. 3	Tainted grain	7½*d.*
No. 4	Badly branded	7½*d.*
No. 5	Badly gouged	7½*d.*

January 31, 1934.

APPENDIX I

RESULTS OF TANNING TRIALS MADE BY THE PENKETH TANNING CO., WITH HIDES FROM THE WET-SEASON AND THE DRY-SEASON EXPERIMENTS

Explanation of Tables

This firm tanned the entire consignment of wet-season hides, consisting of 20 batches of 25 hides each, representing 20 experiments. They tanned half the consignment of dry-season hides, consisting of 20 batches of 12 or 13 hides each, representing 20 experiments similar to those in the wet-season. A total of 500 wet-season hides and 250 dry-season hides.

Experiment Numbers.—The explanation of these is given on pages 44 and 45.

Weight of Hide.—In the second column of the tables the weight of the hide in wet (or fresh) condition is given, while the third column shows the weight of the hide after drying. These figures were supplied by the Kenya authorities.

P.T.C. Dry.—Weight of the hide as recorded by the Penketh Tanning Co.

P.T.C. Pelt Weight.—Weight of the pelt after liming and before trimming.

All weights are given in lbs.

Percentage Gain.— Difference in weight between the pelt and the dry hide, expressed as a percentage of the latter. It may be noted here that a high percentage gain is a desirable feature. The hides from all experiments were generally similar with regard to this factor, and no differentiation between the experiments was made on this basis.

Remarks on Hide in Dry State.—Observations of the Penketh Tanning Co. on the hide as received at the tannery.

Selection of Hide in Dry State.—Grading of the dry hide, as received, into the following classes: Firsts, Seconds, Thirds and Rejects.

Remarks on Pelt in Limed State.—Observations on the quality of the hide after it has been soaked, limed, dehaired and fleshed.

Lime-yard Selection of Bends.—The pelt is trimmed, the belly portions and shoulder portion are cut off, and the remaining major portion or " butt " cut down the middle of the back, thus giving two " bends " from each hide. The bends are graded into the following classes : Firsts, Seconds, Thirds, Fourths, Fifths, " Scab," " Cut " and " Rotten." Bends showing much damage on the grain are classified under " Scab," while those badly cut or gouged are graded as " Cut," and are about equal in value to Fifths. Cuts in the hide may be made in flaying, i.e. in removing the hide from the animal, or when removing the fat and flesh from the hide at a later stage. In the latter case the cutting is more strictly termed " gouging " or " fat laddering." In the Penketh report the term " bad flay " is often used to include both kinds of damage. Pelts which are of no value other than for glue manufacture are termed " Rotten."

In the lime-yard selection none of the bends produced in these trials was classed as a first or second.

WET SEASON. EXPERIMENT W1C (i)

No of hide	Weight Wet	Weight Dry.	P T C Dry	P T C pelt weight	Per centage gain	Remarks on hide in dry state	Selection of hide in dry state	Remarks on pelt in limed state	Lime-yard selection of bends.					
									III	IV	V	Scab	Cut.	Rotten.
1	58	18	19	56	194.7	Branded	III	Sound grain, bad flay	—	—	—	—	2	—
2	42	13	13	38	192.3	Badly branded	II	Sound grain, bad flay	—	—	—	—	2	—
3	55	15	17	52	205.8	Branded	III	Sound, bad flay	—	—	—	—	2	—
4	45	15	13	37	184.6	Branded	I	Sound, cut all over	—	—	—	—	2	—
5	35	17	11	33	200.0	Branded	II	Sound, bad flay	—	—	—	—	2	—
6	43	15	13	42	223.0	Badly branded	III	Slightly heated one spot, bad flay	—	—	—	—	2	—
7	38	12	9	28	211.1	Badly branded	III	Slightly heated one spot, bad flay	—	—	—	—	2	—
8	38	19	11	31	181.8	Badly branded	III	Sound, bad flay	—	—	—	—	2	—
9	34	16	9	28	211.1	Good	II	Sound bad flay	—	—	—	—	2	—
10	38	10	10	33	230.0	Branded	II	Sound, bad flay	—	—	—	—	2	—
11	38	13	11	33	200.0	Good	I	Sound slightly cut	—	—	—	—	2	—
12	45	12	13	40	207.6	Badly branded	III	Sound, bad flay	—	—	—	—	2	—
13	38	12	11	32	190.9	Good	I	Sound bad flay	—	2	—	—	—	—
14	40	14	10	30	200.0	Good	I	Sound worm-eaten, bad flay	—	2	—	—	—	—
15	54	18	15	43	186.6	Badly branded	III	Sound bad flay	—	—	—	—	2	—
16	30	19	15	43	186.6	Badly branded	III	Sound, bad flay	—	—	—	—	2	—
17	50	16	11	33	200.0	Slight hair slip, branded	III	Sound worm-eaten, bad flay	—	—	2	—	—	—
18	46	17	13	35	169.2	Badly branded	III	Sound bad flay	—	—	—	—	2	—
19	32	11	10	28	180.0	Good	I	Sound bad flay	—	—	2	—	—	—
20	54	17	15	46	206.6	Good	I	Sound worm-eaten, bad flay	—	2	—	—	—	—
21	43	14	12	34	183.3	Badly branded	III	Sound bad flay	—	—	—	—	2	—
22	42	15	13	35	169.2	Branded	II	Sound, bad flay	—	—	2	—	—	—
23	45	13	14	40	185.7	Stabbed	I	Sound bad flay	—	—	—	—	2	—
24	44	10	14	41	192.8	Good	II	Sound bad flay	—	—	—	—	2	—
25	51	18	15	43	186.6	Good	I	Sound bad flay	—	2	—	—	—	—

General Remarks on Dry State —Light yellow cure very clean bright hair Very good condition, rather papery hides, much thinner than the W1F (1) cure No signs of grease Mostly badly branded The flesh side appears rather gelatinised Should work sound

General Remarks on Pelt State —Excellent as far as soundness of pelt goes, but all hides badly damaged by cuts all over, deep into the pelt, done when taking off the fat Known to us as "fat laddering" Mostly badly branded Could see no difference between W1C (1) and W6C (1).

Wet Season. Experiment W₁C (ii)

No. of hide.	Weight. Wet.	Weight. Dry.	P.T.C. Dry.	P.T.C. pelt weight.	Percentage gain.	Remarks on hide in dry state.	Selection of hide in dry state	Remarks on pelt in limed state.	Lime-yard selection of bends.					
									III.	IV.	V.	Scab.	Cut.	Rotten.
1	38	19	19	55	189·4	Badly branded	III	Sound, bad flay	—	—	—	1	1	—
2	45	15	15	43	186·6	Badly branded	III	Sound, bad flay	—	—	—	—	2	—
3	47	16	18	46	155·5	Badly branded	III	Sound, bad flay	—	—	—	1	1	—
4	65	13	12	30	150·0	Good	I	Slightly heated grain, badly flayed	—	—	—	—	2	—
5	37	12	15	36	140·0	Badly branded	II	Sound, bad flay	—	1	1	—	—	—
6	42	16	15	41	173·3	Badly branded	III	Sound, bad flay	—	—	—	—	2	—
7	43	15	15	42	180·0	Good	II	Sound, bad flay	—	—	—	—	2	—
8	44	17	19	51	168·4	Badly branded	III	Sound, bad flay	—	—	—	1	1	—
9	38	15	15	41	173·3	Stabbed	II	Sound, stabbed, badly flayed	—	—	—	—	2	—
10	38	15	15	43	186·6	Good	II	Slightly heated, badly flayed	—	—	—	—	2	—
11	35	12	13	34	161·5	Crinkled grain	II	Slightly heated, badly flayed	—	—	—	—	2	—
12	43	10	15	42	180·0	Badly branded	III	Sound, badly flayed	—	1	1	—	—	—
13	45	16	14	46	228·5	Branded	II	Sound, bad flay	—	—	—	—	2	—
14	40	16	15	42	180·0	Badly branded	III	Sound, bad flay	—	—	1	—	1	—
15	39	15	13	41	215·3	Branded	II	Sound, slightly cut	—	—	—	—	2	—
16	43	14	13	38	192·3	Badly branded	III	Slightly putrefied on flesh side, poor flay	—	—	—	—	2	—
17	42	16	15	43	186·6	Badly branded	III	Slight putrefaction on bellies	—	—	—	—	2	—
18	48	17	16	47	193·7	Branded	II	Sound, worm-eaten, poor flay	—	—	—	—	2	—
19	45	16	15	46	206·6	Good	I	Sound but cut to ribbons	—	—	—	—	2	—
20	22	10	7	26	271·4	Good	II	Sound, poor flay	—	—	—	—	2	—
21	30	20	19	56	194·7	Good	I	Sound, poor flay	—	2	—	—	—	—
22	49	18	17	51	200·0	Badly branded	III	Sound, badly flayed	—	—	—	—	2	—
23	38	10	9	28	211·1	Badly branded	III	Sound, badly flayed	—	1	1	—	—	—
24	35	13	13	35	169·2	Good	I	Sound, bad flay	—	—	—	—	2	—
25	37	15	14	43	207·1	Good	I	Sound, bad flay	—	2	—	—	—	—

General Remarks on Dry State.—Very good condition. Light-coloured flesh cure. Good bright hair, appeared gelatinised on flesh side. **Rather thin and papery compared with the "F."** Should work sound.

General Remarks on Pelt State.—All sound pelt, mostly badly branded. All spoiled by bad fat laddering when taking off the fat. Every hide deeply gouged right into pelt. A good cure.

WET SEASON. EXPERIMENT W1C (iii)

No of hide	Weight Wet	Weight Dry	P T C Dry	P T C pelt weight	Per centage gain	Remarks on hide in dry state	Selection of hide in dry state	Remarks on pelt in limed state	Lime yard selection of bends.					
									III.	IV	V	Scab	Cut.	Rotten.
1	47	15	13	34	161.5	Good	I	Slight tender grain, badly cut	—	—	2	—	—	—
2	38	13	11	30	172.7	Good	I	Very slightly heated grain, badly cut	—	—	—	—	2	—
3	47	18	11	31	181.8	Good	I	Badly heated grain, poor flay	—	—	—	2	—	—
4	31	14	10	27	170.0	Branded all over	III	Sound poor flay	—	—	2	—	—	—
5	58	20	12	36	200.0	Good	I	Slightly heated grain, poor flay	—	—	2	—	—	—
6	36	12	16	45	181.2	Branded, stabbed	II	Badly heated grain all over, poor flay	—	—	—	2	—	—
7	45	18	15	39	160.0	Good	I	Sound cut all over	—	—	—	—	2	—
8	52	20	13	39	200.0	Stabbed	II	Sound cracked grain poor flay	—	—	—	—	2	—
9	38	13	15	45	200.0	Badly branded	III	Slightly heated grain badly branded	—	—	1	1	—	—
10	40	15	13	35	169.2	Good	I	Sound poor flay	—	—	—	—	2	—
11	57	22	15	42	180.0	Branded all over	III	Sound poor flay	—	—	2	—	—	—
12	58	14	15	49	226.6	Badly branded, stabbed	III	Sound poor flay	—	—	—	—	2	—
13	50	19	13	39	200.0	Good	I	Sound cracked grain poor flay	—	—	—	—	2	—
14	39	13	17	54	217.6	Branded	II	Sound poor flay	—	—	—	—	2	—
15	44	18	13	42	223.0	Good	I	Sound cracked grain, poor flay	—	—	—	—	2	—
16	40	17	14	41	192.8	Branded scabby	III	Sound poor flay	—	—	—	—	2	—
17	45	20	12	36	200.0	Branded	II	Sound poor flay	—	—	—	—	2	—
18	35	15	12	38	216.6	Good	I	Sound poor flay	—	—	—	—	2	—
19	50	20	20	63	215.0	Good	I	Slightly heated grain, rough and stabbed	—	—	—	—	2	—
20	32	15	12	34	183.3	Good	I	Sound rough grain, poor flay	—	—	—	—	2	—
21	45	20	11	29	163.6	Branded	III	Sound, poor flay	—	—	—	—	2	—
22	32	15	13	34	161.5	Good	I	Slightly heated grain, poor flay	—	—	—	—	2	—
23	58	18	17	50	194.1	Badly branded	III	Sound, poor flay	—	—	—	—	2	—
24	30	20	12	36	200.0	Good	I	Sound, poor flay	—	—	—	—	2	—
25	46	20	10	28	180.0	Branded	II	Sound, cracked grain, poor flay	—	—	—	—	2	—

General Remarks on Dry State—Very dry condition not greasy at all. Rather thin and papery Greenish-yellow cure, slightly transparent. Good bright hair

General Remarks on Pelt State—Not very sound hides mostly slightly heated grain Some badly heated all over Many cracked grain. All hides damaged by bad flay or gouging due to taking the fat off This cure not so sound as (i) or (ii)

WET SEASON. EXPERIMENT W1C (iv)

No of hide	Weight Wet	Weight Dry	P T C Dry	P T C pelt weight	Per centage gain	Remarks on hide in dry state	Selection of hide in dry state	Remarks on pelt in limed state	Lime-yard selection of bends. III	IV	V	Scab	Cut.	Rotten.
1	29	13	13	40	207·6	Slightly worm-eaten	II	Very slightly heated grain, poor flay	—	—	—	—	2	—
2	55	11	12	33	175·0	Slightly worm-eaten	II	Tender grain, cracked, poor flay	—	—	1	1	—	—
3	40	11	10	28	180·0	Slightly worm-eaten	II	Sound, poor flay	—	2	—	—	—	—
4	45	10	9	28	211·1	Branded, worm-eaten	II	Heated grain, poor flay	—	—	—	—	2	—
5	47	11	12	30	150·0	Branded	II	Heated grain, cracked, poor flay	—	—	2	—	—	—
6	40	13	12	36	200·0	Badly branded	III	Slightly heated grain, cracked, poor flay	—	1	1	—	—	—
7	38	14	13	38	192·3	Branded	II	Sound, poor flay	—	—	2	—	—	—
8	37	17	17	46	170·0	Good	I	Sound, poor flay	—	—	—	—	2	—
9	38	11	11	34	209·0	Branded, worm-eaten	II	Tender grain, poor flay	—	1	—	—	1	—
10	39	15	15	42	180·0	Branded	II	Sound, poor flay	—	—	—	—	2	—
11	40	9	8	22	175·0	Badly branded	III	Sound, poor flay	—	—	—	—	2	—
12	39	13	13	37	184·6	Branded	II	Sound, slightly worm-eaten, poor flay	—	1	1	—	—	—
13	35	12	11	37	235·4	Badly branded	III	Slightly putrefied grain, poor flay	—	—	—	1	1	—
14	32	11	10	32	220·0	Badly branded	III	Sound, poor flay	—	—	—	1	1	—
15	25	18	17	50	194·1	Badly branded	III	Slightly putrefied, poor flay	—	—	—	—	2	—
16	40	12	11	34	209·0	Good	I	Sound, fair flay	—	—	—	—	2	—
17	44	14	17	51	200·0	Good	I	Sound, poor flay	—	—	—	—	2	—
18	51	12	12	39	225·0	Branded, stabbed	II	Tender grain in spots, poor flay	—	—	—	—	2	—
19	35	15	14	45	221·4	Good	I	Sound, slightly cut	—	2	—	—	—	—
20	42	15	14	44	214·2	Good	I	Slightly cracked grain, poor flay	—	—	—	—	2	—
21	28	13	12	37	208·3	Good	II	Sound, poor flay	—	—	—	—	2	—
22	43	12	11	35	217·3	Good	II	Sound, slightly cut	—	2	—	—	—	—
23	39	10	11	33	200·0	Good	I	Sound, cracked grain, poor flay	—	—	—	—	2	—
24	32	11	11	32	190·9	Good	II	Sound, poor flay	—	2	—	—	—	—
25	44	13	13	38	192·3	Worm-eaten	III	Slightly putrefied in spots	—	—	—	—	2	—

General Remarks on Dry State.—Very clean greenish-yellow cure, good condition No signs of grease or fat Papery and thin, very bright hair. Mostly badly branded; look as though they should work fairly sound

General Remarks on Pelt State.—Many slightly heated on the grain, some badly. Mostly badly branded and practically all spoilt by bad flay, due to fat gouging, when removing fat Not much difference between this cure and W1C (iii)

WET SEASON. EXPERIMENT W1C (v)

No. of hide.	Weight. Wet.	Weight. Dry.	P.T.C. Dry.	P.T.C. pelt weight.	Per-centage gain.	Remarks on hide in dry state.	Selection of hide in dry state	Remarks on pelt in limed state.	Lime-yard selection of bends.					
									III.	IV.	V.	Scab.	Cut.	Rotten.
1	51	16	17	51	200·0	Very badly branded	III	Very slightly heated grain, poor flay	—	—	1	—	1	—
2	51	18	16	45	181·2	Branded	II	Slightly heated grain, poor flay	—	—	—	—	2	—
3	49	15	16	44	175·0	Good	I	Slightly heated grain, poor flay	—	—	2	—	—	—
4	42	12	14	38	171·4	Good	I	Sound, poor flay	—	—	—	—	2	—
5	44	13	13	38	192·3	Good	I	Sound, poor flay	—	—	—	—	2	—
6	41	12	12	34	183·3	Good	I	Very slightly heated grain, poor flay	—	2	—	—	—	—
7	44	14	14	41	192·8	Branded, stabbed	II	Sound, poor flay	—	—	—	—	2	—
8	43	13	12	40	233·3	Badly branded	III	Sound, poor flay	—	—	—	—	2	—
9	45	15	14	41	192·8	Very slight hair slip	II	Slightly heated grain in patches	—	—	—	2	—	—
10	45	12	12	37	208·3	Very slight hair slip	II	Heated grain, poor flay	—	—	—	—	2	—
11	38	12	12	33	175·0	Stabbed	II	Slightly heated grain, poor flay	—	—	—	—	2	—
12	40	16	16	48	200·0	Very slight hair slip, branded	III	Slightly heated grain, poor flay	—	—	—	—	2	—
13	52	13	11	35	217·2	Good	I	Tender grain, bad flay	—	—	—	—	2	—
14	43	14	12	40	233·3	Good	I	Putrefied grain, poor flay	—	—	2	—	—	—
15	31	10	8	23	187·5	Good	I	Sound, poor flay	—	—	—	—	2	—
16	34	17	16	46	187·5	Good	I	Slightly heated grain, poor flay	—	—	—	—	2	—
17	55	19	16	49	206·2	Good	I	Sound, poor flay	—	—	—	—	2	—
18	35	11	9	35	288·8	Good	I	Slightly putrefied grain, poor flay	—	—	—	—	2	—
19	35	10	9	34	277·7	Good	I	Heated grain in patches, poor flay	—	—	—	—	2	—
20	49	15	14	46	228·5	Good	III	Sound, poor flay	—	—	—	2	—	—
21	47	17	15	46	206·6	Good	I	Sound, poor flay	—	—	—	—	2	—
22	60	18	16	55	243·7	Badly branded	III	Slightly heated grain in patches, poor flay	—	—	—	—	2	—
23	39	13	11	36	227·2	Good	II	Sound, poor flay	—	—	—	—	2	—
24	43	14	13	43	230·7	Good	II	Slightly putrefied grain, poor flay	—	—	—	—	2	—
25	41	13	11	37	236·3	Good	I	Sound, poor flay	—	—	—	—	2	—

General Remarks on Dry State.—Appear fairly sound, very bright hair; some bad hair slipping, but no putrefied holes like W1F (v) and W6F (v). Very clean, no signs of grease, greenish-yellow cure. Quite a different proposition to W1F (v) and W6F (v).

General Remarks on Pelt State.—Mostly slightly heated grain, some badly putrefied. Certainly the worst cure of the W1C. All badly damaged by gouging, caused by removing the fat. Badly branded. These turned out much sounder than W1F (v) and W6F (v).

WET SEASON. EXPERIMENT W1F (i)

No. of hide.	Weight. Wet.	Weight. Dry.	P.T.C. Dry.	P.T.C. pelt weight.	Per-centage gain.	Remarks on hide in dry state.	Selection of hide in dry state.	Remarks on pelt in limed state.	Lime-yard selection of bends.					
									III.	IV.	V.	Scab.	Cut.	Rotten.
1	35	23	22	62	181·8	Very badly branded	III	Badly branded, grease-marked, poor flay	—	—	2	—	—	—
2	39	20	20	55	175·0	Stabbed, slight hair slip	II	Sound, grease-marked, poor flay	—	—	—	—	2	—
3	40	18	16	46	187·5	Badly branded	III	Sound, badly branded, poor flay	—	—	—	—	2	—
4	35	25	23	62	169·5	Slightly worm-eaten	II	Sound, grease-marked, poor flay	—	1	1	—	—	—
5	44	21	20	58	190·0	Stabbed, slight hair slip	II	Sound, badly grease-marked, poor flay	—	—	—	—	2	—
6	33	30	29	76	162·0	Hair slip, worm-eaten	III	Very slightly heated grain around tail	—	1	1	—	—	—
7	36	20	18	52	188·8	Badly branded	III	Sound, badly branded, poor flay	—	—	—	—	2	—
8	40	18	14	40	185·7	Good	I	Sound, grease-marked, poor flay	—	2	—	—	—	—
9	37	17	15	44	193·3	Good	I	Sound, badly grease-marked	—	2	—	—	—	—
10	33	19	15	39	160·0	Good	I	Slightly heated where grease-marked	—	—	—	—	2	—
11	40	20	17	48	182·3	Good	I	Slightly heated around tail	—	2	—	—	—	—
12	44	19	17	43	152·9	Good, small brand	I	Sound, poor flay	—	2	—	—	—	—
13	41	19	18	42	133·3	Slightly putrefied, worm-eaten	II	Slightly tender grain, worm-eaten	—	—	1	—	1	—
14	61	25	24	71	195·8	Worm-eaten, crinkled grain	II	Sound, poor flay	—	2	—	—	—	—
15	43	19	16	48	200·0	Worm-eaten, crinkled grain	I	Sound but cut to ribbons	—	—	—	—	2	—
16	44	19	18	50	177·7	Good	I	Sound, silky grain, grease-marked	1	1	—	—	—	—
17	65	28	25	66	164·0	Slight hair slip	II	Slightly heated, badly grease-marked	—	—	—	—	2	—
18	49	20	17	47	176·4	Good	I	Grain slightly tender where grease-marked	—	1	1	—	—	—
19	45	16	16	45	181·2	Good	II	Sound but grease-marked	1	1	—	—	—	—
20	60	25	23	72	213·0	Slightly worm-eaten	II	Sound pelt, slightly grease-marked	—	2	—	—	—	—
21	44	20	15	46	206·6	Good	I	Very slightly putrefied, poor flay	—	2	—	—	—	—
22	51	19	20	56	180·0	Badly branded	III	Sound, grain tender where grease-marked	—	2	—	—	—	—
23	61	25	24	60	150·0	Very badly branded	III	Sound, badly branded	—	1	1	—	—	—
24	39	23	13	40	207·7	Slight brands	II	Tender grain where grease-marked	—	2	—	—	—	—
25	32	12	12	32	166·6	Branded all over	III	Sound but badly branded	—	1	1	—	—	—

General Remarks on Dry State.—Rather darkish cure. Very clean, but very greasy, which attracted the worms. **Very clean bright hair selection. Badly branded. One or two slight hair slips.**

General Remarks on Pelt State.—**Many of the hides were grease-marked with heated grain on these marks, practically all appearing round the tail.** Poor flay, badly branded.

WET SEASON. EXPERIMENT W1F (ii)

No of hide	Weight Wet	Weight Dry	P T C Dry	P T C pelt weight	Per centage gain	Remarks on hide in dry state	Selection of hide in dry state	Remarks on pelt in limed state	Lime-yard selection of bends					
									III	IV	V	Scab	Cut	Rotten
1	Not weighed	14	13	38	192.3	Slight hair slip	II	Sound branded poor flay	—	—	—	—	2	—
2		17	17	48	182.3	Good	I	Sound but branded	—	2	—	—	—	—
3		15	19	48	152.6	Branded	II	Sound badly branded	—	1	1	—	—	—
4		23	22	62	181.8	Branded	II	Sound badly branded poor flay	—	2	—	—	—	—
5		19	18	47	161.1	Very badly branded	III	Sound badly branded poor flay	—	1	1	—	—	—
6		19	18	52	188.8	Worm eaten hump	II	Sound poor flay	—	—	—	—	2	—
7		20	20	61	205.0	Good	II	Sound poor flay	—	2	—	—	—	—
8		13	12	33	175.0	Badly branded	III	Sound badly branded	—	1	1	—	—	—
9		16	16	43	168.7	Good	I	Sound poor flay	—	2	—	—	—	—
10	39	15	15	41	173.3	Good	I	Sound badly branded	—	2	—	—	—	—
11	31	15	14	35	150.0	Stabbed	II	Sound badly branded	—	1	—	—	1	—
12	35	14	14	36	157.1	Badly branded	III	Sound badly branded poor flay	—	—	—	—	2	—
13	55	25	27	71	162.9	Branded	II	Sound badly branded poor flay	—	—	—	—	2	—
14	30	11	9	30	233.3	Worm eaten grain	II	Sound badly branded	—	—	2	—	—	—
15	51	22	20	56	180.0	Good	II	Sound badly cut	—	—	—	—	2	—
16	46	18	17	48	182.3	Good	I	Sound badly branded	—	1	1	—	—	—
17	38	13	12	39	225.0	Good	I	Sound slightly worm eaten grain	—	2	—	—	—	—
18	69	27	27	72	166.6	Branded	II	Sound badly branded poor flay	—	—	1	—	1	—
19	43	18	17	45	164.7	Very wrinkled looks dangerous	II	Sound badly branded	—	2	—	—	—	—
20	50	20	19	54	184.2	Branded	II	Sound branded poor flay	—	—	—	—	2	—
21	37	14	12	37	208.3	Worm eaten grain	II	Sound worm eaten grain	—	—	—	—	2	—
22	52	22	22	56	154.5	Wrinkled grain	II	Sound very badly branded	—	1	—	—	1	—
23	60	21	18	56	211.1	Worm-eaten grain	II	Sound cut to ribbons	—	—	—	—	2	—
24	51	23	23	58	152.1	Slightly wrinkled	II	Slightly putrefied where grease marked	—	1	1	—	—	—
25	33	13	12	35	191.6	Good	I	Sound slightly grease-marked	—	2	—	—	—	—

General Remarks on Dry State —Light yellow cure on flesh very clean no dirt rubbed in Very greasy flesh which attracted the worms Some damaged grain All hides more or less badly branded Bright hair Dry condition practically no signs of hair slip

General Remarks on Pelt State —Very sound pelt and not grease-marked so badly as W6F (ii) Hardly any signs of tender grain Very poorly flayed Badly branded

WET SEASON. EXPERIMENT W I F (iii)

No of hide	Weight Wet	Weight Dry.	P T C Dry	P T C pelt weight	Per centage gain	Remarks on hide in dry state	Selection of hide in dry state	Remarks on pelt in limed state	Lime-yard selection of bends.					
									III	IV	V	Scab	Cut.	Rotten.
1	40	17	14	44	214.2	Good	I	Slightly putrefied grain and flesh	—	—	—	—	2	—
2	40	16	15	41	173.7	Branded	II	Sound grain, badly branded	—	1	1	—	—	—
3	49	20	18	51	183.3	Slightly crinkled grain	II	Sound badly grease-marked	—	—	—	—	2	—
4	38	15	14	43	207.1	Slightly crinkled grain	I	Slightly putrefied flesh, tender grain	—	—	—	—	2	—
5	40	15	14	42	200.0	Slightly crinkled grain	II	Badly putrefied flesh, blistered grain	—	—	—	—	2	—
6	50	29	20	54	170.0	Slightly crinkled grain	II	Tender grain, grease-marked	—	2	—	—	—	—
7	45	17	16	46	187.5	Good	II	Sound bad flay	—	—	—	—	2	—
8	38	14	12	37	208.3	Crinkled grain	I	Blistered grain, bad flay	—	—	2	—	—	—
9	47	18	16	45	181.2	Branded	II	Badly blistered, putrefied flesh side	—	—	—	2	—	—
10	45	18	16	49	206.2	Badly branded	III	Putrefied flesh blistered grain	—	—	2	—	—	—
11	40	15	14	40	185.7	Branded	II	Badly putrefied flesh, blistered grain	—	—	2	—	—	—
12	35	15	12	35	191.6	Good	I	Badly putrefied flesh, tender grain	—	—	—	2	—	—
13	41	17	16	46	187.5	Good	II	Sound badly branded	—	—	—	1	1	—
14	30	14	13	32	146.1	Worm eaten hump	II	Badly putrefied flesh, blistered grain	—	—	2	—	—	—
15	60	16	25	64	156.0	Crinkled grain	I	Very badly blistered grain, putrefied	—	—	—	2	—	—
16	40	10	15	38	153.3	Worm eaten hump	II	Slight putrefied grain, worm-eaten	—	2	—	—	—	—
17	50	15	20	48	140.0	Worm-eaten	II	Putrefied flesh side in holes	—	—	2	—	—	—
18	38	14	13	34	161.5	Worm-eaten hump	II	Slightly heated grain	—	2	—	—	—	—
19	39	14	15	40	166.6	Badly crinkled	II	Slightly putrefied from flesh side	—	2	—	—	—	—
20	52	20	20	49	145.0	Worm-eaten, crinkled	II	Slightly putrefied flesh and grain	—	—	2	—	—	—
21	49	18	21	47	123.8	Good	I	Sound, grease marked	—	2	—	—	—	—
22	53	22	21	55	161.6	Good	I	Slightly heated grain	—	—	2	—	—	—
23	68	25	25	67	168.0	Branded, stabbed	II	Sound	—	1	1	—	—	—
24	54	21	21	55	161.6	Good	I	Very badly heated, worm-eaten	—	—	—	2	—	—
25	50	16	14	36	157.1	Hair slip, crinkled	III	Slightly heated grain	—	—	2	—	—	—

General Remarks on Dry State.—Rather dark yellow cure, very clean, practically all hides good bright hair No signs of slip, but most hides seemed crinkled on grain side as though they had been dried too quickly and the hide snatched, otherwise good.

General Remarks on Pelt State.—Most of the hides were putrefied from flesh side, and showed heated grain in the pitted form. Rather poor. It rather looks as though the crinkled grain has something to do with the putrefaction.

WET SEASON. EXPERIMENT W1F (iv)

No. of hide.	Weight. Wet.	Weight. Dry.	P.T.C. Dry.	P.T.C. pelt weight.	Percentage gain.	Remarks on hide in dry state.	Selection of hide in dry state.	Remarks on pelt in limed state.	Lime-yard selection of bends.					
									III.	IV.	V.	Scab.	Cut.	Rotten.
1	40	16	15	41	173·3	Very bad hair slip	III	Badly heated grain, putrefied flesh	—	—	—	2	—	—
2	42	15	14	44	214·2	Slight hair slip	II	Badly heated grain, putrefied in holes	—	—	2	—	—	—
3	31	19	11	30	172·7	Slight hair slip	II	Badly putrefied grain and flesh	—	—	—	2	—	—
4	46	16	17	48	182·3	Slight hair slip	II	Very badly heated grain all over	—	—	1	1	—	—
5	42	19	16	46	187·5	Bad hair slip	III	Heated grain, badly putrefied flesh side	—	—	—	2	—	—
6	55	20	20	60	200·0	Worm-eaten, putrefied	III	Very badly heated grain all over	—	—	—	2	—	—
7	43	12	15	41	173·3	Bad hair slip, worm-eaten	III	Putrefied grain in holes	—	—	—	2	—	—
8	44	17	16	43	168·7	Slight hair slip, worm-eaten	II	Heated grain, badly putrefied flesh	—	—	2	—	—	—
9	40	12	15	40	166·6	Slight hair slip	II	Putrefied all over in holes	—	—	—	2	—	—
10	50	16	19	52	173·6	Slight putrefaction	II	Badly heated grain, putrefied flesh	—	—	2	—	—	—
11	40	19	14	44	214·2	Very bad hair slip	III	Very badly heated grain	—	—	2	—	—	—
12	46	20	18	57	216·6	Very bad hair slip	III	So badly heated no grain left	—	—	—	2	—	—
13	59	21	23	61	165·2	Bad hair slip, putrefied	III	Very badly heated grain, putrefied flesh	—	—	—	2	—	—
14	38	19	15	48	220·0	Good	II	Badly heated grain	—	—	1	1	—	—
15	31	11	11	33	200·0	Good	II	Fairly sound, slightly heated on hump	—	2	—	—	—	—
16	45	18	14	47	235·7	Worm-eaten, crinkled	III	Badly heated in spots due to grease	—	—	—	2	—	—
17	45	17	16	45	181·2	Putrefied, worm-eaten	III	Badly putrefied all over	—	—	—	2	—	—
18	49	14	18	56	211·1	Hair slip, putrefied	III	Badly heated in holes, grease-marked	—	—	—	2	—	—
19	50	20	18	56	211·1	Hair slip, slightly putrefied	III	Slightly putrefied, badly grease-marked	—	—	2	—	—	—
20	30	19	18	52	188·8	Slight hair slip	III	Very badly heated all over	—	—	1	1	—	—
21	30	12	12	33	175·0	Good	I	Slightly putrefied, grease-marked	—	—	—	2	—	—
22	32	11	11	32	190·9	Crinkled grain	II	Very badly putrefied grain	—	—	—	2	—	—
23	40	12	14	40	185·7	Rubbed grain	II	Slightly putrefied all over	—	—	2	—	—	—
24	47	15	15	48	220·0	Good	II	Very slightly heated grain	—	—	1	1	—	—
25	47	12	15	45	200·0	Slight hair slip	II	Tender grain, putrefied flesh side	—	—	—	2	—	—

General Remarks on Dry State.—Practically all the hides have suffered from hair slip, during drying, which means that putrefaction must have started. Very different from hair condition of hides' cures Nos. (1)–(iii). Rather light yellow flesh cure, looks rather dangerous.

General Remarks on Pelt State.—Very poor lot. Practically all badly heated on grain side due to the grease partly, which had marked the grain. Most hides putrefied in patches from flesh side. A very poor cure.

WET SEASON. EXPERIMENT W1F (v)

No of hide	Weight Wet	Weight Dry.	P T C. Dry.	P.T C pelt weight.	Per-centage gain	Remarks on hide in dry state	Selection of hide in dry state.	Remarks on pelt in limed state.	Lime-yard selection of bends.					
									III	IV.	V.	Scab	Cut.	Rotten.
1	35	11	10	33	230·0	Hair slip, worm-eaten	III	Practically all the batch thrown for glue	—	—	—	2	—	—
2	54	15	14	38	171·4	Hair slip, putrefied	Reject		—	—	—	2	—	—
3	45	13	14	38	171·4	Very bad hair slip	Reject		—	—	—	—	—	2
4	36	10	10	28	180·0	Very bad hair slip, putrefied	Reject		—	—	—	—	—	2
5	42	12	11	35	217·2	Hair slip, putrefied, worm-eaten	Reject		—	—	—	—	—	2
6	62	17	16	52	225·0	Hair slip, putrefied, worm-eaten	Reject		—	—	—	—	—	2
7	40	12	11	35	217·2	Hair slip, putrefied, worm-eaten	Reject		—	—	—	2	—	—
8	55	16	16	51	218·7	Very bad hair slip	III		—	—	—	—	—	2
9	46	15	14	44	214·2	Hair slip, putrefied, worm-eaten	Reject		—	—	—	—	—	2
10	39	12	12	32	166·6	Slight hair slip	II		—	—	—	—	—	2
11	37	12	11	33	200·0	Bad hair slip, putrefied	Reject		—	—	—	—	—	2
12	45	13	12	40	233·3	Hair slip putrefied, worm-eaten	Reject		—	—	—	2	—	—
13	35	10	9	32	255·5	Bad hair slip, putrefied	Reject		—	—	—	—	—	2
14	45	13	12	39	225·0	Bad hair slip, putrefied	Reject		—	—	—	—	—	2
15	35	11	10	32	220·0	Very bad hair slip	Reject		—	—	—	2	—	—
16	48	11	13	37	184·6	Bad hair slip, putrefied	Reject		—	—	—	—	—	2
17	43	11	11	47	327·2	No hair on at all	Reject		—	—	—	—	—	2
18	30	9	8	21	162·5	Bad hair slip, worm-eaten	Reject		—	—	—	—	—	2
19	59	16	15	50	233·3	No hair on at all	Reject		—	—	—	—	—	2
20	41	11	11	36	227·2	Bad hair slip, putrefied	Reject		—	—	—	—	—	2
21	40	11	10	39	290·0	Bad hair slip	III		—	—	—	—	—	2
22	47	13	13	42	223·0	Very bad hair slip	Reject		—	—	—	—	—	2
23	48	14	11	38	245·4	Very soft, putrefied	Reject		—	—	—	—	—	—
24	39	12	12	30	150·0	Very bad hair slip	Reject		—	—	—	—	—	2
25	40	14	13	33	153·8	Bad hair slip, putrefied	Reject		—	—	—	—	—	2

General Remarks on Dry State.—Very dangerous-looking lot of hides, all very bad hair slip and putrefied, many in holes. Rather soft, and feel dampish, but this may be caused by the fat or grease. Mostly worm-eaten, imagine these will go to glue. The worst cure of the five.

General Remarks on Pelt State.—Practically all rotten hides. Never seen a worse parcel of hides. This cure absolutely useless, if all hides turn out similarly.

WET SEASON. EXPERIMENT W6C (i)

No. of hide.	Weight. Wet.	Weight. Dry.	P.T.C. Dry.	P.T C. pelt weight.	Per-centage gain.	Remarks on hide in dry state.	Selection of hide in dry state	Remarks on pelt in limed state.	Lime-yard selection of bends.					
									III.	IV.	V.	Scab.	Cut.	Rotten.
1	51	18	16	44	175·0	Good	I	Sound, bad flay	—	2	—	—	—	—
2	40	13	12	33	175·0	Branded	II	Sound, bad flay	—	2	—	—	—	—
3	50	15	13	40	207·6	Good	I	Sound, bad flay	—	2	—	—	—	—
4	45	15	14	38	171·4	Good	I	Sound, bad flay	—	2	—	—	—	—
5	55	17	15	42	180·0	Badly branded	III	Sound, bad flay	—	2	—	—	—	—
6	45	15	15	39	160·0	Badly branded, stabbed	III	Sound, bad flay	—	1	1	—	—	—
7	42	12	11	33	200·0	Badly branded	III	Sound, bad flay	—	1	1	—	—	—
8	52	19	16	47	193·1	Very badly branded	II	Sound, bad flay	—	—	—	—	2	—
9	51	16	15	42	180·0	Very badly branded	III	Sound, bad flay	—	1	1	—	—	—
10	31	10	8	23	187·5	Badly stabbed	II	Slightly heated grain, bad flay	—	2	—	—	—	—
11	30	13	11	32	190·9	Good	I	Sound, bad flay	—	—	—	—	2	—
12	42	12	10	32	220·0	Good	I	Sound, bad flay	—	—	—	—	2	—
13	40	12	10	28	180·0	Branded, stabbed	II	Sound, bad flay	—	—	—	—	2	—
14	45	14	12	37	208·3	Good	I	Sound, bad flay	—	—	—	—	2	—
15	55	18	16	45	181·2	Good	I	Sound, bad flay	—	—	—	—	2	—
16	54	19	16	50	212·5	Badly branded	III	Sound, bad flay	—	—	—	—	2	—
17	50	16	14	47	235·7	Branded	II	Sound, bad flay	—	—	—	—	2	—
18	55	17	15	42	180·0	Good	I	Sound, bad flay	—	—	—	—	2	—
19	33	11	9	28	211·1	Very badly branded	III	Sound, bad flay	—	—	—	—	2	—
20	40	17	14	41	192·8	Branded	III	Sound, bad flay	—	—	—	2	—	—
21	35	14	12	39	225·0	Branded	III	Sound, bad flay	—	—	—	—	2	—
22	40	15	14	40	185·7	Branded	II	Sound, bad flay	—	—	—	—	2	—
23	35	13	10	33	230·0	Badly branded	II	Sound, bad flay	—	—	—	—	2	—
24	30	10	9	28	211·1	Branded, stabbed	III	Sound, bad flay	—	—	—	2	—	—
25	50	18	15	49	226·6	Badly branded	II	Sound, bad flay	—	—	—	—	2	—

General Remarks on Dry State.—Very clean cure both hair and flesh sides. No signs of grease. Very good condition. Appeared rather gelatinised from flesh side, the hair roots being visible. Badly branded. Bright hair. The hides seemed very papery and thin. Look as though should work sound. Could see no difference between W1C (i) and W6C (i).

General Remarks on Pelt State.—A very sound lot of hides. This method of curing certainly excellent as far as soundness is concerned. All hides badly damaged by taking the fat off, as nearly every hide was badly cut deep into the pelt all over, what we term "fat laddering." Most hides badly branded.

WET SEASON. EXPERIMENT W6C (ii)

No. of hide.	Weight. Wet.	Weight. Dry.	P.T.C. Dry.	P.T.C. pelt weight.	Per-centage gain.	Remarks on hide in dry state.	Selection of hide in dry state.	Remarks on pelt in limed state.	Lime-yard selection of bends.					
									III.	IV.	V.	Scab.	Cut.	Rotten.
1	42	14	13	40	207·6	Branded	II	Sound, bad flay	—	—	2	—	—	—
2	40	18	17	52	205·8	Branded	II	Sound, bad flay	—	—	—	—	2	—
3	43	13	13	39	200·0	Good	II	Sound, bad flay	—	—	—	—	2	—
4	45	14	13	41	215·3	Badly branded	III	Sound, bad flay	—	—	—	—	2	—
5	49	15	17	47	176·4	Good	II	Sound, fair flay	—	2	—	—	—	—
6	68	22	21	68	223·8	Good	II	Sound, cracked, bad flay	—	—	—	—	2	—
7	53	16	14	52	271·4	Branded	II	Sound, bad flay	—	—	—	—	2	—
8	43	13	13	41	215·3	Good	I	Sound, bad flay	—	—	—	—	2	—
9	49	10	16	49	206·2	Badly branded	I	Sound, bad flay	—	—	—	—	2	—
10	33	21	9	28	211·1	Badly branded	III	Sound, bad flay	—	—	1	1	—	—
11	59	15	20	58	190·0	Branded	III	Sound, bad flay	—	—	1	1	—	—
12	52	11	15	48	220·0	Branded	II	Sound, bad flay	—	2	—	—	—	—
13	36	20	12	30	150·0	Good	I	Sound, worm-eaten, bad flay	—	—	—	—	2	—
14	57	12	20	56	180·0	Badly branded, stabbed	III	Sound, badly branded, bad flay	—	—	2	—	—	—
15	58	12	12	34	183·3	Good	I	Sound, bad flay	—	1	1	—	—	—
16	70	10	13	36	176·9	Good	I	Sound, cracked, bad flay	—	2	—	—	—	—
17	54	14	19	47	147·3	Good	I	Sound, bad flay	—	—	—	—	2	—
18	51	16	16	44	175·0	Crinkled grain	II	Sound, stabbed, bad flay	—	2	—	—	—	—
19	50	14	18	45	150·0	Good	I	Sound, stabbed, bad flay	—	2	—	—	—	—
20	44	13	15	40	166·6	Good	I	Sound, bad flay	—	2	—	—	—	—
21	43	18	15	39	160·0	Good	I	Slightly heated grain, bad flay	—	2	—	—	—	—
22	51	21	19	47	147·3	Good	I	Sound, bad flay	—	—	—	—	2	—
23	58	21	21	54	157·1	Good	I	Sound, bad flay	—	—	—	—	—	—
24	38	11	13	34	161·5	Branded	III	Sound, bad flay	—	1	—	—	1	—
25	37	13	13	34	161·5	Good	I	Sound, bad flay	—	2	—	—	—	—

General Remarks on Dry State.—Very clean light-coloured flesh. Bright hair; rather gelatinised appearance on flesh side. Feel rather papery and thin. No signs of grease or fat. Cannot see any difference between W1C (ii) and W6C (ii).

General Remarks on Pelt State.—Very sound pelt, good grain spoilt by branding and bad flay caused by taking off the fat. Practically all hides badly fat laddered, being gouged deep into the pelt all over.

WET SEASON. EXPERIMENT W6C (iii)

No. of hide.	Weight. Wet.	Weight. Dry.	P.T.C. Dry.	P.T.C. pelt weight.	Per-centage gain.	Remarks on hide in dry state.	Selection of hide in dry state.	Remarks on pelt in limed state.	Lime-yard selection of bends.					
									III.	IV.	V.	Scab.	Cut.	Rotten.
1	62	22	21	58	176·1	Branded	II	Sound, cracked grain, poor flay	—	2	—	—	—	—
2	41	15	13	40	207·6	Badly branded	III	Slightly heated grain, poor flay	—	—	—	—	2	—
3	33	10	9	28	211·1	Branded	II	Sound, poor flay	—	1	1	—	—	—
4	58	18	15	56	273·3	Branded	II	Sound, rough grain, poor flay	—	—	—	—	2	—
5	49	16	16	47	193·7	Branded	I	Sound, cracked grain, poor flay	—	2	—	—	—	—
6	51	16	15	48	220·0	Branded	II	Sound, poor flay	—	2	—	—	—	—
7	40	14	12	37	208·3	Branded	II	Slightly heated, poor flay	—	—	2	—	—	—
8	49	16	15	44	193·3	Branded	II	Slightly heated grain, poor flay	—	—	—	—	2	—
9	53	19	16	52	225·0	Badly branded	III	Sound, poor flay	—	—	—	—	2	—
10	45	15	13	39	200·0	Branded	II	Sound, poor flay	—	—	—	1	1	—
11	41	16	13	37	184·6	Badly branded	III	Slightly heated grain, badly branded	—	—	—	2	—	—
12	48	16	15	44	193·3	Badly branded	III	Sound, poor flay	—	—	—	—	2	—
13	49	12	15	47	213·3	Branded	II	Sound, cracked grain, poor flay	—	2	—	—	—	—
14	39	18	13	33	153·8	Branded	II	Sound, cracked grain, poor flay	—	1	1	—	—	—
15	53	13	18	51	183·3	Badly branded, stabbed	II	Sound, poor flay	—	1	1	—	—	—
16	40	18	13	37	184·6	Badly branded, worm-eaten	III	Sound, poor flay	—	—	—	1	1	—
17	54	16	19	56	194·7	Good	I	Sound, poor flay	—	—	—	—	2	—
18	51	15	16	48	200·0	Good	I	Sound, cracked grain, poor flay	—	—	—	—	2	—
19	45	14	15	40	166·6	Good	I	Sound, poor flay	—	—	—	—	2	—
20	43	15	15	39	160·0	Badly branded	III	Slightly heated grain, poor flay	—	—	1	—	1	—
21	46	19	15	44	193·3	Badly branded	III	Sound, poor flay	—	1	1	—	—	—
22	54	23	19	52	173·6	Worm-eaten on the belly	I	Sound, worm-eaten, poor flay	—	—	—	—	2	—
23	43	17	14	45	221·4	Good	II	Sound, poor flay	—	—	—	—	2	—
24	50	14	18	48	166·6	Good	I	Sound, worm-eaten, poor flay	—	2	—	—	—	—
25	45	14	14	38	171·4	Good	I	Sound, poor flay	—	2	—	—	—	—

General Remarks on Dry State.—Good condition, no signs of grease. Rather thin and papery. Greenish-yellow cure, slightly transparent. Good bright hair. No difference perceivable between W1C (iii) and W6C (iii).

General Remarks on Pelt State.—On the whole fairly sound, some heated on grain, and cracked, also worm-eaten. All spoiled by bad flay or fat gouging due to removing fat. This cure not so sound as (i) or (ii).

WET SEASON. EXPERIMENT W6C (iv)

No. of hide.	Weight Wet.	Weight. Dry.	P.T.C. Dry.	P.T.C. pelt weight.	Per-centage gain.	Remarks on hide in dry state.	Selection of hide in dry state.	Remarks on pelt in limed state.	Lime-yard selection of bends.					
									III.	IV.	V.	Scab.	Cut.	Rotten.
1	29	15	15	41	173·3	Branded	II	Heated grain, cracked, poor flay	—	—	1	—	1	—
2	55	11	13	34	161·5	Branded	II	Tender grain, cracked, poor flay	—	—	—	—	2	—
3	40	11	17	48	182·3	Branded, stabbed	II	Sound, cut to ribbons	—	—	—	—	2	—
4	45	10	12	36	200·0	Branded	II	Sound, poor flay	—	—	2	—	—	—
5	47	11	13	36	178·9	Good	I	Sound, cracked grain, poor flay	—	—	—	—	2	—
6	40	13	16	42	162·5	Branded	II	Very slightly heated grain, poor flay	—	—	2	—	—	—
7	38	14	17	51	200·0	Good	II	Very slightly heated grain, poor flay	—	2	—	—	—	—
8	37	17	13	38	192·3	Good	I	Sound, cracked grain, poor flay	—	—	—	—	2	—
9	38	11	12	36	200·0	Badly branded	III	Sound, poor flay	—	1	—	1	—	—
10	39	15	12	36	200·0	Badly branded	III	Very slightly heated grain, poor flay	—	2	—	—	—	—
11	40	9	13	33	153·8	Badly branded	III	Sound, poor flay	—	—	—	1	1	—
12	39	13	16	46	187·5	Badly branded	III	Sound, very badly branded	—	—	2	—	—	—
13	35	12	10	34	240·0	Good	I	Sound, poor flay	—	—	—	—	2	—
14	32	11	15	49	226·6	Good	II	Sound, poor flay	—	2	—	—	—	—
15	35	18	11	32	190·9	Branded	II	Slightly tender grain, poor flay	—	2	—	—	—	—
16	40	12	11	36	236·3	Good	I	Slightly putrefied, poor flay	—	—	—	—	2	—
17	44	14	10	28	180·0	Good	I	Sound, poor flay	—	—	—	1	1	—
18	51	12	11	37	235·4	Good	II	Heated grain, poor flay	—	—	2	—	—	—
19	35	15	13	42	223·0	Good	I	Slightly putrefied in two spots, poor flay	—	—	—	—	2	—
20	42	15	11	35	217·2	Good	II	Slightly heated grain, poor flay	—	1	1	—	—	—
21	28	12	11	35	217·2	Good	I	Sound	—	2	—	—	—	—
22	43	12	14	48	242·8	Badly branded	III	Sound, poor flay	—	1	1	—	—	—
23	39	10	8	33	312·5	Good	I	Sound, poor flay	—	—	—	—	2	—
24	32	11	14	43	207·1	Good	II	Sound, poor flay	—	—	—	—	2	—
25	45	13	17	48	182·3	Badly branded	III	Sound, poor flay	—	1	1	—	—	—

General Remarks on Dry State.—Very good condition, no signs of grease or fat. Papery and thin, bright hair. Mostly badly branded. Greenish-yellow cure; could see no difference from W1C (iv).

General Remarks on Pelt State.—Quite a number sound, but on the whole slightly heated grain, rather tender. All spoilt by bad gouging caused by taking the fat off. Mostly very badly branded. Very much sounder than W1F (iv) and W6F (iv).

WET SEASON. EXPERIMENT W6C (v)

No. of hide.	Weight. Wet.	Weight. Dry.	P.T.C. Dry.	P.T.C. pelt weight.	Percentage gain.	Remarks on hide in dry state.	Selection of hide in dry state	Remarks on pelt in limed state	Lime-yard selection of bends. III.	IV.	V.	Scab.	Cut.	Rotten.
1	52	16	14	47	235·7	Slight hair slip	II	Slightly putrefied grain, bad flay	—	—	—	—	2	—
2	43	14	13	42	223·0	Slight hair slip	II	Badly putrefied in patches, poor flay	—	—	2	—	—	—
3	39	12	10	33	230·0	Good	II	Slightly heated grain, poor flay	—	—	2	—	—	—
4	46	15	13	43	230·7	Branded	II	Slightly putrefied one spot, poor flay	—	—	—	—	2	—
5	32	19	8	27	237·5	Branded	I	Slightly heated grain, poor flay	—	—	—	—	2	—
6	51	18	17	53	211·7	Slight hair slip	II	Slightly heated grain, poor flay	—	—	2	—	—	—
7	50	15	14	47	235·7	Branded	II	Sound, bad flay	—	—	—	—	2	—
8	30	10	8	26	225·0	Good	I	Sound, fair flay	—	—	—	—	2	—
9	36	10	9	31	244·4	Good	I	Sound, poor flay	—	—	—	—	2	—
10	40	21	20	63	215·0	Branded	II	Slightly heated grain, poor flay	—	—	—	—	2	—
11	45	21	19	59	210·5	Good	I	Putrefied grain, bad flay	—	—	—	—	2	—
12	39	12	11	33	200·0	Putrefied, hair slip	III	Slightly putrefied, poor flay	—	—	2	—	—	—
13	42	12	13	39	200·0	Good	I	Sound, poor flay	—	—	—	—	2	—
14	60	20	19	56	194·7	Good	I	Sound, poor flay	—	—	—	—	2	—
15	60	19	18	52	188·8	Good	I	Slightly heated grain, poor flay	—	—	2	—	—	—
16	59	19	19	56	194·7	Rather bad hair slip all over	III	Badly heated grain all over	—	—	—	2	—	—
17	40	12	11	32	190·9	Badly branded	III	Badly heated grain all over	—	—	—	2	—	—
18	38	19	17	55	223·5	Slight hair slip	II	Very slightly heated grain	—	—	—	—	2	—
19	35	10	9	20	222·2	Good	I	Sound, poor flay	—	2	—	—	—	—
20	41	13	13	38	192·3	Slight hair slip, branded	III	Slightly heated grain, poor flay	—	—	—	—	2	—
21	39	11	11	33	200·0	Slight hair slip	II	Slightly heated all over	—	—	—	2	—	—
22	54	17	17	51	200·0	Bad hair slip	III	Very badly heated grain, poor flay	—	—	—	2	—	—
23	45	10	10	32	220·0	Slight hair slip, worm-eaten	II	Heated grain all over	—	—	—	—	2	—
24	51	16	15	47	213·3	Bad hair slip, worm-eaten	III	Very badly heated grain all over	—	—	—	2	—	—
25	46	16	14	40	185·7	Slight hair slip	II	Heated grain all over in spots	—	—	—	2	—	—

General Remarks on Dry State.—Rather darkish yellow cure, very clean flesh. No signs of fat or grease. Slight hair slip on one or two; very bad on some. Good bright hair. No putrefied holes. The fat having been removed may be the reason for this.

General Remarks on Pelt State.—Mostly slightly heated grain, some badly putrefied. No difference between W1C (v) and W6C (v). All badly gouged and mostly branded.

WET SEASON. EXPERIMENT W6F (i)

No. of hide.	Weight. Wet.	Weight. Dry.	P.T.C. Dry.	P.T.C. pelt weight.	Per-centage gain.	Remarks on hide in dry state.	Selection of hide in dry state.	Remarks on pelt in limed state.	Lime-yard selection of bends.					
									III.	IV.	V.	Scab.	Cut.	Rotten.
1	50	20	19	49	157·8	Branded	II	Sound, badly branded	—	2	—	—	—	—
2	40	16	15	40	166·6	Good	I	Sound, poor flay	—	2	—	—	—	—
3	50	19	17	49	188·2	Hair slip	II	Sound, poor flay	2	—	—	—	—	—
4	50	21	19	54	184·2	Badly branded	III	Sound, grease-marked, branded	—	1	1	—	—	—
5	43	18	14	50	257·1	Badly branded, hair slip	III	Slightly tender grain, branded	—	1	1	—	—	—
6	40	19	17	44	158·8	Branded	II	Sound, badly grease-marked	—	2	—	—	—	—
7	45	21	19	52	173·6	Very greasy	II	Slightly tender grain where grease-marked	—	2	—	—	—	—
8	40	18	17	47	176·4	Branded	II	Sound, badly branded	—	1	1	—	—	—
9	42	18	16	44	175·0	Badly branded	III	Tender grain where grease-marked	—	1	1	—	—	—
10	40	17	14	40	185·7	Branded, greasy	II	Sound, small brands	2	—	—	—	—	—
11	30	23	20	60	200·0	Badly branded	III	Sound, but badly branded	—	—	2	—	—	—
12	30	12	—	31	—	—	—	Sound, but slightly grease-marked	2	—	—	—	—	—
13	69	25	23	39	69·5	Good	II	Sound, poor flay	—	2	—	—	—	—
14	35	15	13	34	161·5	Good	I	Sound, badly branded	—	2	—	—	—	—
15	40	18	16	40	150·0	Hair slip on hump	II	Sound, badly branded, grease-marked	—	—	—	—	2	—
16	51	22	20	55	175·0	Good	I	Slightly heated where grease-marked	—	2	—	—	—	—
17	41	20	15	39	160·0	Very slight hair slip	II	Slightly heated where grease-marked	—	—	2	—	—	—
18	39	16	13	38	192·3	Bad flay	II	Sound, poor flay	—	2	—	—	—	—
19	47	22	17	48	182·3	Bad flay	II	Slightly heated grain round tail	—	—	—	—	2	—
20	44	17	16	48	200·0	Good	I	Sound, poor flay	—	—	—	—	2	—
21	32	12	11	30	172·7	Badly branded	III	Sound, badly branded	—	1	1	—	—	—
22	44	21	18	43	137·2	Badly branded	III	Slight heated grain where grease-marked	—	1	—	1	—	—
23	44	19	17	42	147·0	Badly branded	III	Sound, badly branded	—	—	2	—	—	—
24	49	23	20	56	180·0	Branded all over	III	Sound, badly branded, poor flay	—	—	—	—	2	—
25	44	19	17	42	147·0	Branded	II	Sound, but poor flay	—	2	—	—	—	—

General Remarks on Dry State.—Very dull cure, clean bright hair. Most of the hides were very greasy, which attracted the worms. Badly branded. Some hides show hair slip.

General Remarks on Pelt Stage.—Sound pelt on the whole, but practically all spoilt by grease-marks round tail, with tender or heated grain on the grease-marks. The fat or grease seems to have worked right through from the flesh. Mostly badly branded, with poor flay.

WET SEASON. EXPERIMENT W6F (ii)

No. of hide.	Weight. Wet.	Weight. Dry.	P.T.C. Dry.	P.T.C. pelt weight.	Per-centage gain.	Remarks on hide in dry state.	Selection of hide in dry state.	Remarks on pelt in limed state.	Lime-yard selection of bends.					
									III.	IV.	V.	Scab.	Cut.	Rotten.
1	49	20	18	51	183·3	Worm-eaten, branded	II	Badly putrefied where grease-marked	—	—	—	1	1	—
2	50	20	19	56	194·7	Branded	III	Tender grain where grease-marked	—	—	2	—	—	—
3	43	16	15	46	206·6	Worm-eaten	II	Badly heated grain Poor flay	—	—	2	—	—	—
4	53	20	17	56	229·4	Badly branded	III	Tender grain where grease-marked	—	—	—	2	—	—
5	41	17	15	42	180·0	Slightly worm-eaten	II	Tender grain, worm-eaten	—	—	1	—	1	—
6	42	15	13	39	200·0	Good	II	Heated grain where grease-marked	—	2	—	—	—	—
7	44	18	16	48	200·0	Badly branded	III	Sound, branded, grease-marked	—	1	1	—	—	—
8	52	21	19	55	189·4	Good	II	Slightly heated where grease-marked	—	—	—	—	2	—
9	41	16	14	41	192·9	Badly branded	III	Tender grain, badly grease-marked	—	—	1	1	—	—
10	45	18	15	41	173·3	Branded	II	Badly grease-marked, tender grain	—	—	1	—	1	—
11	55	22	22	59	168·1	Very wrinkled grain	II	Slightly heated grain round tail	—	—	—	—	2	—
12	39	15	12	37	205·3	Very wrinkled Dried too fast	II	Slightly heated round tail due to grease	—	2	—	—	—	—
13	43	17	16	46	187·5	Good	I	Sound, slightly grease-marked	—	2	—	—	—	—
14	40	16	16	42	162·5	Good	I	Very slightly heated round tail	—	2	—	—	—	—
15	30	15	9	26	188·8	Good	I	Sound but poor flay	—	2	—	—	—	—
16	42	17	16	44	175·0	Good	II	Badly heated grain, poor flay	—	—	2	—	—	—
17	43	18	17	44	158·8	Very slight hair slip	II	Sound, badly grease-marked	—	2	—	—	—	—
18	45	18	17	52	205·8	Slight hair slip, badly branded	II	Sound, badly branded	—	—	—	—	2	—
19	39	14	13	38	192·3	Good	I	Sound, grease-marked, poor flay	—	—	—	—	2	—
20	50	20	19	51	168·4	Good	I	Sound, slightly grease-marked	—	2	—	—	—	—
21	48	20	19	51	168·4	Good	I	Sound, badly branded	—	2	—	—	—	—
22	49	19	18	49	172·2	Good	I	Slightly heated grain where grease-marked	—	—	—	—	2	—
23	53	20	20	52	160·0	Good	I	Sound, badly branded	—	—	2	—	—	—
24	40	15	15	40	166·6	Good	I	Sound	—	2	—	—	—	—
25	42	16	16	48	200·0	Slightly worm-eaten, branded	II	Sound, badly branded, grease-marked	—	2	—	—	—	—

General Remarks on Dry State.—Very yellow flesh cure, very clean, no signs of earth having been rubbed in. Very fatty, the fat seems to have attracted the worm. Good hair appearance except hides Nos. 11 and 12, wrinkled grain as though snatched in drying. Most hides very badly branded; flay not visible.

General Remarks on Pelt State.—On the whole fairly sound pelt, but most hides were grease-marked, which caused the grain to be tender. The grease seems to have worked through from the flesh side to the grain. Most hides very badly branded, poor flay. Many hides slightly worm-eaten on grain.

WET SEASON. EXPERIMENT W6F (iii)

No. of hide.	Weight. Wet	Weight Dry.	P.T.C. Dry.	P.T.C pelt weight.	Per-centage gain.	Remarks on hide in dry state.	Selection of hide in dry state.	Remarks on pelt in limed state.	Lime-yard selection of bends.					
									III.	IV.	V.	Scab	Cut.	Rotten.
1	36	11	12	32	166·6	Bad hair slip	III	Badly putrefied grain and flesh	—	—	—	2	—	—
2	36	11	12	32	166·6	Very bad hair slip	III	Badly heated grain, grease-marked	—	—	—	2	—	—
3	44	17	16	42	162·5	Bad hair slip	III	Very badly heated grain all over	—	—	—	2	—	—
4	55	20	21	56	166·6	Dangerous, bad hair slip	III	Very badly putrefied grain	—	—	—	2	—	—
5	56	21	22	58	163·6	Crinkled grain	II	Sound, badly branded	—	1	1	—	—	—
6	43	20	21	55	161·9	Good	I	Sound	—	2	—	—	—	—
7	50	16	17	41	141·1	Worm-eaten, crinkled	III	Badly putrefied, blistered in holes	—	—	—	2	—	—
8	46	18	18	49	172·4	Crinkled grain	II	Very badly putrefied from flesh side	—	—	—	2	—	—
9	38	17	17	45	164·7	Hair slip	III	Putrefied from flesh side, worm-eaten	—	—	—	2	—	—
10	43	12	14	35	150·0	Good	II	Badly putrefied flesh side	—	—	2	—	—	—
11	43	15	17	43	152·9	Badly crinkled grain	II	Slightly putrefied grain and flesh	—	—	2	—	—	—
12	49	20	18	54	200·0	Badly crinkled grain	II	Very badly putrefied grain	—	—	—	2	—	—
13	32	13	12	35	191·6	Branded	II	Slightly putrefied in patches all over	—	2	—	—	—	—
14	35	12	12	38	216·6	Worm-eaten, crinkled	II	Badly heated grain, putrefied flesh	—	—	—	1	1	—
15	42	16	14	48	242·8	Slight hair slip	II	Heated grain, slightly putrefied flesh	—	—	2	—	—	—
16	39	21	12	34	183·3	Slight hair slip	II	Tender grain, putrefied flesh side	—	—	—	2	—	—
17	32	13	13	34	161·5	Branded	II	Heated grain, putrefied flesh	—	—	2	—	—	—
18	55	20	20	61	205·0	Hair slip, crinkled	III	Badly heated grain all over	—	—	—	2	—	—
19	43	11	13	36	176·9	Good	II	Badly putrefied flesh, blistered grain	—	—	—	2	—	—
20	38	12	12	37	208·3	Good	I	Very slightly heated grain	—	2	—	—	—	—
21	45	18	17	53	211·7	Branded	II	Very slightly heated grain	—	—	—	—	2	—
22	33	11	10	36	260·0	Badly branded	III	Badly heated grain	—	—	2	—	—	—
23	42	16	15	45	200·0	Slight hair slip	II	Badly heated grain all over	—	—	—	—	2	—
24	39	14	13	41	215·3	Branded	II	Quite sound	—	2	—	—	—	—
25	40	15	15	38	153·3	Slight hair slip	II	Badly heated grain, putrefied flesh	—	—	—	2	—	—

General Remarks on Dry State.—Very clean cure, darkish flesh. Many hides crinkled on grain as though snatched in drying. One or two hides with slight hair slip. Rather greasy.

General Remarks on Pelt State.—Practically all hides putrefied on flesh side. Badly heated grain in pitted form. A better cure than W6F (iv) and W1F (iv).

WET SEASON. EXPERIMENT W6F (iv)

No. of hide.	Weight Wet.	Weight. Dry.	P.T.C. Dry.	P.T.C. pelt weight.	Percentage gain.	Remarks on hide in dry state.	Selection of hide in dry state.	Remarks on pelt in limed state.	Lime-yard selection of bends.					
									III.	IV.	V.	Scab.	Cut.	Rotten.
1	47	15	14	48	242·8	Bad hair slip	III	Badly heated grain, grease-marked	—	—	—	2	—	—
2	38	13	11	38	245·4	Slight hair slip	II	Putrefied grain all over	—	—	—	2	—	—
3	47	18	17	55	223·5	Slight hair slip	II	Very badly heated grain	—	—	—	2	—	—
4	31	14	10	32	220·0	Hair slip, crinkled grain	II	Slightly putrefied, grease-marked	—	2	—	—	—	—
5	58	20	19	57	200·0	Very bad hair slip	III	Badly heated grain all over	—	—	—	2	—	—
6	36	12	11	32	190·9	Hair slip and crinkled	II	Badly putrefied grain all over	—	—	1	1	—	—
7	45	18	15	43	186·6	Badly putrefied	III	Practically rotten, badly putrefied	—	—	—	2	—	—
8	52	20	19	55	189·4	Hair slip and putrefied	II	Badly heated grain all over	—	—	—	2	—	—
9	38	15	12	38	216·0	Slight hair slip	III	Badly heated grain due to grease	—	—	2	—	—	—
10	40	15	13	34	161·5	Slight hair slip	III	Badly heated grain all over	—	—	—	2	—	—
11	57	22	20	63	215·0	Bad hair slip	III	Badly heated grain, grease-marked	—	—	—	2	—	—
12	58	14	13	39	200·0	Slight hair slip	III	Slightly putrefied, grease-marked	—	—	2	—	—	—
13	50	19	18	48	166·6	Badly putrefied	III	Very badly heated grain all over	—	—	—	2	—	—
14	39	13	13	37	184·6	Putrefied, hair slip	III	Heated grain, putrefied flesh in holes	—	—	2	—	—	—
15	49	18	18	47	161·1	Bad hair slip	III	Badly heated grain, putrefied flesh	—	—	—	2	—	—
16	40	17	16	40	150·0	Crinkled grain	II	Sound, badly branded	—	2	—	—	—	—
17	45	20	20	52	160·0	Badly branded	III	Slightly tender grain, badly branded	—	1	—	1	—	—
18	35	15	14	38	171·4	Good	I	Slightly putrefied, badly branded	—	1	1	—	—	—
19	50	20	20	53	165·0	Good	I	Very slightly heated grain	—	2	—	—	—	—
20	32	15	13	37	184·6	Badly branded	III	Very badly heated grain, putrefied flesh	—	—	—	2	—	—
21	45	20	17	45	164·7	Slight hair slip	II	Sound, but grease-marked	—	1	1	—	—	—
22	32	15	8	23	187·5	Worm-eaten	II	Badly heated grain, putrefied flesh	—	2	—	—	—	—
23	58	18	19	50	163·1	Badly branded, crinkled	II	Sound, badly branded	—	1	1	—	—	—
24	30	20	11	30	172·7	Slight hair slip	II	Slightly tender grain	—	2	—	—	—	—
25	46	20	17	48	182·3	Badly branded	III	Slightly heated grain, badly branded	—	—	—	2	—	—

General Remarks on Dry State.—Light yellow cure, very clean flesh, no signs of earth. Practically all the hides were in a slipping condition before drying and must have started putrefaction One or two very badly putrefied. Look rather dangerous. If anything these were worse for hair slip than W1F (iv). The flesh was rather greasy.

General Remarks on Pelt State.—Very poor lot. Practically all badly heated on grain side due to the grease partly, which had marked the grain. Most hides putrefied in patches from flesh side. A very poor cure. Could see no difference between W1F (iv) and W6F (iv).

WET SEASON. EXPERIMENT W6F (v)

No. of hide.	Weight Wet.	Weight. Dry	P T C. Dry.	P.T.C. pelt weight.	Per-centage gain.	Remarks on hide in dry state.	Selection of hide in dry state.	Remarks on pelt in limed state.	Lime-yard selection of bends.					
									III.	IV.	V.	Scab	Cut.	Rotten.
1	35	16	15	38	153·3	Putrefied holes, hair slip	III	This batch is absolute rubbish	—	—	—	2	—	—
2	66	12	11	30	172·7	Hair slip all over	III		—	—	—	—	—	2
3	50	18	18	56	211·1	Very bad hair slip	III		—	—	—	2	—	—
4	50	13	12	33	175·0	Slight hair slip	II		—	—	—	—	—	2
5	60	15	13	41	215·3	Bad hair slip, putrefied	III		—	—	—	—	—	2
6	58	14	13	35	169·2	Very bad hair slip, putrefied	Reject		—	—	—	—	—	2
7	43	16	14	54	285·7	Hair slip all over	Reject		—	—	—	—	—	2
8	47	12	11	30	172·7	Bad hair slip	III		—	—	—	—	—	2
9	30	18	16	—	—	Bad hair slip, worm-eaten	Reject		—	—	—	—	—	2
10	42	17	16	47	193·7	Slight hair slip, worm-eaten	III		—	—	—	2	—	—
11	30	11	10	33	230·0	Very bad hair slip	Reject		—	—	—	—	—	2
12	42	21	20	54	170·0	No hair left on	Reject		—	—	—	—	—	2
13	40	18	17	53	211·7	Hair slip, putrefied holes	Reject		—	—	—	2	—	—
14	42	18	18	56	211·1	Hair slip, worm-eaten	III		—	—	—	2	—	—
15	48	21	22	63	186·3	Bad hair slip all over	III		—	—	—	—	—	2
16	40	20	20	61	205·0	All hair off, putrefied holes	Reject		—	—	—	—	—	2
17	35	16	14	38	171·4	Bad hair slip, very soft	Reject		—	—	—	—	—	2
18	40	14	14	41	192·8	Hair slip, putrefied, soft	Reject		—	—	—	—	—	2
19	32	18	18	53	194·4	Slight hair slip	II		—	—	—	—	—	2
20	40	15	14	35	150·0	Hair slip, badly worm-eaten	Reject		—	—	—	—	—	2
21	45	19	17	56	229·4	Putrefied in holes, very soft	Reject		—	—	—	—	—	2
22	40	15	15	44	193·3	Soft, putrefied, hair slip	Reject		—	—	—	—	—	2
23	39	15	13	40	207·6	Hair slip, worm-eaten	III		—	—	—	2	—	—
24	50	14	13	47	261·5	Hair slip, worm-eaten	Reject		—	—	—	—	—	2
25	50	18	16	54	237·5	Badly putrefied, soft	Reject		—	—	—	2	—	—

General Remarks on Dry State.—Very dangerous lot of hides, mostly with bad hair slip, and putrefied. The hides were soft and dampish, and were very greasy. The dampish feel may be due to the fat having melted at some time and started putrefaction. Consider most hides will go rotten in process.

General Remarks on Pelt State.—This cure absolutely useless. Practically all hides rotten. No difference from W1F (v). Both atrocious.

DRY SEASON. EXPERIMENT D1C (i)

No. of hide.	Weight. Wet.	Weight. Dry.	P.T.C. Dry.	P.T.C. pelt weight.	Per-centage gain	Remarks on hide in dry state.	Selection of hide in dry state.	Remarks on pelt in limed state.	Lime-yard selection of bends.					
									III.	IV.	V.	Scab.	Cut.	Rotten.
13	33	14	14	34	142·8	Badly branded	III	Sound, very badly branded, bad flay	—	—	—	—	2	—
14	42	15	16	41	156·2	Small brand	II	Sound, badly cut	—	—	—	—	2	—
15	34	12	16	32	100·0	Worm-eaten	II	Sound, badly cut	—	—	—	—	2	—
16	34	13	12	30	150·0	Good	I	Sound, bad flay	—	—	—	—	2	—
17	46	14	16	45	181·2	Worm-eaten	II	Sound, bad flay, badly branded	—	—	1	1	—	—
18	40	13	14	37	164·2	Badly branded	III	Sound, bad flay, badly branded	—	1	1	—	—	—
19	37	13	14	36	157·1	Stabbed	II	Sound, bad flay	—	2	—	—	—	—
20	40	15	15	39	160·0	Good	I	Sound, bad flay	—	—	—	—	2	—
21	37	14	14	35	150·0	Good	I	Sound, bad flay	—	—	—	—	2	—
22	43	16	15	46	206·6	Worm-eaten	II	Sound, bad flay, slightly worm-eaten	—	—	—	—	2	—
23	30	11	11	30	172·6	Good	I	Sound, bad flay	—	—	—	—	2	—
24	45	12	18	51	183·3	Badly branded	III	Sound, bad flay, badly branded	—	2	—	—	—	—
25	33	9	12	32	166·6	Badly branded	III	Sound, bad flay	—	2	—	—	—	—

General Remarks on Dry State.—Rather transparent light yellow cure, very good condition. Nice bright hair, worm-eaten, mostly branded, look quite sound.

General Remarks on Pelt State.—Very sound lot of pelt all spoilt by bad gouging, caused by removing the fat. Most hides very badly branded.

DRY SEASON. EXPERIMENT D1C (ii)

No of hide.	Weight. Wet.	Weight Dry.	P.T C. Dry.	P.T.C pelt weight.	Per-centage gain.	Remarks on hide in dry state.	Selection of hide in dry state	Remarks on pelt in limed state.	Lime-yard selection of bends.					
									III.	IV.	V.	Scab.	Cut.	Rotten.
39	30	10	10	28	180·0	Good, branded	II	Sound, bad flay	—	—	—	—	2	—
40	48	16	16	47	193·7	Badly branded	II	Very slightly heated round tail	—	—	—	—	2	—
41	48	17	16	46	187·5	Good	I	Sound, bad flay	—	—	—	—	2	—
42	33	13	13	36	176·9	Good	I	Sound, bad flay, badly branded	—	—	—	—	2	—
43	51	18	18	50	177·7	Good	I	Sound, bad flay	—	—	—	—	2	—
44	47	17	17	46	170·5	Branded	II	Sound, worm-eaten, bad flay	—	—	—	—	2	—
45	39	14	14	38	171·6	Badly branded	III	Sound, bad flay	—	—	—	—	2	—
46	39	11	13	35	169·2	Badly branded	III	Slightly heated all down backbone	—	—	—	—	2	—
47	50	19	18	47	161·1	Good, branded	II	Sound, bad flay	—	—	—	—	2	—
48	59	17	20	55	175·0	Badly branded	III	Sound, very badly branded, bad flay	—	1	1	—	—	—
49	47	17	17	46	170·5	Good	III	Sound, bad flay	—	2	—	—	—	—
50	38	14	14	39	178·5	Branded	II	Sound, bad flay	—	—	—	—	2	—

General Remarks on Dry State.—Very good condition, good bright hair, look very nice, mostly branded, should work sound.

General Remarks on Pelt State.—Very sound cure, practically similar to D1C (i). Hardly any signs of heated grain. All spoilt by gouging due to removing the fat. Mostly badly branded.

DRY SEASON. EXPERIMENT DiC (iii)

No. of hide.	Weight. Wet.	Weight Dry.	P.T.C. Dry.	P.T.C. pelt weight.	Percentage gain.	Remarks on hide in dry state.	Selection of hide in dry state.	Remarks on pelt in limed state.	Lime-yard selection of bends.					
									III.	IV.	V.	Scab.	Cut.	Rotten.
63	44	15	14	47	235·7	Badly branded	III	Badly heated	—	—	—	2	—	—
64	45	13	14	44	214·2	Badly branded	III	Badly heated	—	—	—	2	—	—
65	50	14	15	49	226·6	Good	I	Badly putrefied	—	—	—	2	—	—
66	41	13	13	40	207·6	Good	I	Badly heated	—	—	—	2	—	—
67	45	13	14	43	207·1	Badly branded	III	Badly putrefied	—	—	—	2	—	—
68	48	7	14	45	221·4	Badly branded	II	Slightly heated all over	—	—	—	—	2	—
69	44	15	14	44	214·2	Badly branded	II	Badly heated	—	—	—	2	—	—
70	61	15	21	61	190·4	Branded, stabbed	II	Absolutely rotten	—	—	—	—	—	2
71	37	12	12	36	200·0	Good	I	Badly heated	—	—	—	2	—	—
72	62	22	22	61	177·2	Good	I	Putrefied, heated	—	—	—	2	—	—
73	37	13	13	43	230·7	Good	I	Badly heated	—	—	2	—	—	—
74	38	10	10	36	260·0	Badly branded, stabbed	III	Slightly heated all over	—	—	—	2	—	—
75	41	12	12	38	216·6	Good	I	Badly heated	—	—	—	2	—	—

General Remarks on Dry State.—Appear quite good, no signs of hair slip or worm, only badly branded. Good condition, clean cure, bright hair. Should work sound.

General Remarks on Pelt State.—Mostly badly heated and putrefied. A very poor lot of hides. All badly gouged.

Dry Season. Experiment DiC (iv)

No. of hide.	Weight. Wet.	Weight. Dry.	P.T.C. Dry.	P.T.C. pelt weight.	Per-centage gain.	Remarks on hide in dry state.	Selection of hide in dry state.	Remarks on pelt in limed state.	Lime-yard selection of bends.					
									III.	IV.	V.	Scab.	Cut.	Rotten.
87	42	16	19	—	—	—	—	—	—	—	—	—	—	—
88	43	18	—	—	—	—	—	—	—	—	—	—	—	—
89	48	17	18	48	166·6	Badly branded	II	Slightly heated	—	—	—	—	2	—
90	33	10	9	28	211·1	Badly branded	III	Sound, badly flayed	—	—	—	—	2	—
91	46	15	13	41	215·3	Good	I	Badly heated	—	—	—	2	—	—
92	44	13	14	43	207·1	Badly branded	II	Badly heated	—	—	—	—	2	—
93	34	11	11	33	200·0	Good	I	Slightly heated all over, bad flay	—	—	—	—	2	—
94	41	13	13	40	207·6	Badly branded	III	Putrefied	—	—	—	2	—	—
95	62	22	21	60	185·7	Badly branded	III	Putrefied, worm-eaten	—	—	—	2	—	—
96	45	11	15	43	186·6	Good	II	Badly heated	—	—	—	2	—	—
97	58	19	19	56	194·7	Stabbed	II	Badly heated	—	—	—	—	2	—
98	47	16	16	49	206·2	Good	I	Heated all over	—	—	—	2	—	—
99	31	9	9	28	211·1	Branded	II	Putrefied, cracked	—	—	—	—	2	—
100	39	12	12	36	200·0	Badly branded	III	Badly heated	—	—	—	2	—	—

General Remarks on Dry State.—Very good, no signs of hair slip. Clean cure, good condition. Badly branded, no signs of grease.

General Remarks on Pelt State.—Mostly slightly heated grain, some badly putrefied, all badly gouged.

DRY SEASON. EXPERIMENT D1C (v)

No. of hide.	Weight. Wet.	Weight. Dry.	P.T.C. Dry.	P.T.C. pelt weight.	Per-centage gain.	Remarks on hide in dry state.	Selection of hide in dry state.	Remarks on pelt in limed state.		Lime-yard selection of bends.					
										III.	IV.	V.	Scab.	Cat.	Rotten.
113	43	15	14	40	185·7	Good	I	Sound, bad flay	Practically all badly branded	—	—	—	—	2	—
114	31	10	9	28	211·1	Good	I	Sound, bad flay		—	—	—	—	2	—
115	50	17	15	48	220·0	Good	I	Sound, bad flay		—	—	—	—	2	—
116	29	9	8	25	212·5	Badly branded, stabbed	III	Sound, bad flay		—	—	—	—	2	—
117	49	16	14	46	228·5	Good	I	Sound, bad flay		—	—	—	—	2	—
118	70	25	23	72	213·0	Badly branded	II	Sound, bad flay		—	—	—	—	2	—
119	50	12	16	48	200·0	Good	I	Sound, bad flay		—	—	—	—	2	—
120	50	17	16	49	206·2	Good	I	Sound, bad flay		—	—	—	—	2	—
121	38	12	12	33	175·0	Branded	II	Sound, bad flay		—	—	—	—	2	—
122	42	15	14	42	200·0	Good	I	Sound, bad flay		—	—	—	—	2	—
123	37	13	11	34	209·0	Good	I	Sound, bad flay		—	—	—	—	2	—
124	51	19	18	52	188·8	Branded, worm-eaten on belly edge	II	Sound, bad flay		—	2	—	—	—	—
125	39	13	13	38	192·2	Badly branded	III	Sound, bad flay		—	—	—	—	2	—

General Remarks on Dry State.—Bright hair, very good condition, not greasy. Look as though should work sound. Vastly different from W1F (v) and W6F (v). No signs of hair slip.

General Remarks on Pelt State.—Very sound lot of hides, no signs of any heated grain. Bad flay. Mostly branded.

DRY SEASON. EXPERIMENT D1F (i)

No. of hide.	Weight. Wet.	Weight. Dry.	P.T.C. Dry.	P.T.C. pelt weight.	Percentage gain.	Remarks on hide in dry state.	Selection of hide in dry state.	Remarks on pelt in limed state.	Lime-yard selection of bends.					
									III.	IV.	V.	Scab	Cut.	Rotten.
139	33	15	13	37	184·6	Worm-eaten shoulder	II	Slightly heated where grease-marked	—	—	2	—	—	—
140	42	18	16	45	181·2	Good	I	Sound, poor flay	—	2	—	—	—	—
141	57	22	21	61	190·4	Good	I	Sound, poor flay	—	1	1	—	—	—
142	40	17	15	41	173·3	Slightly worm-eaten	II	Sound, poor flay	—	—	—	—	2	—
143	45	21	18	51	183·3	Slightly worm-eaten	II	Sound, poor flay	—	2	—	—	—	—
144	47	20	18	50	177·7	Good	I	Sound	—	2	—	—	—	—
145	45	19	17	49	188·2	Good	I	Sound, grease-marked, poor flay	—	—	—	—	2	—
146	52	21	21	61	190·4	Good	I	Sound, very bad flay	—	—	—	—	2	—
147	47	19	18	53	194·4	Slightly worm-eaten	II	Sound, badly cut	—	2	—	—	—	—
148	45	17	16	46	187·5	Good	I	Slightly heated round tail	—	2	—	—	—	—
149	39	15	15	43	186·6	Slightly worm-eaten	II	Sound, grease-marked	—	2	—	—	—	—
150	40	16	15	47	213·3	Good	I	Sound, badly flayed	—	2	—	—	—	—

General Remarks on Dry State.—Worm-eaten slightly on flesh and grain, otherwise good bright hair. Clean cure, rather greasy.

General Remarks on Pelt State.—Generally sound pelt, some grease-marked, badly branded. Poor flay, two very slightly heated where grease-marked.

DRY SEASON. EXPERIMENT D1F (II)

No of hide	Weight Wet	Weight Dry	P T C Dry	P T C pelt weight	Per centage gain	Remarks on hide in dry state	Selection of hide in dry state	Remarks on pelt in limed state	Lime yard selection of bends.					
									III	IV	V	Scab	Cut	Rotten.
163	42	17	17	45	164 7	Slight worm	II	Very slightly heated grain	—	2	—	—	—	—
164	48	19	19	49	157 8	Good	I	Very badly putrefied all along back bone	—	2	—	—	—	—
165	37	14	13	36	176 9	Good	I	Badly putrefied all along back bone	—	2	—	—	—	—
166	36	13	13	34	161 5	Good	I	Slightly putrefied all down the back bone	—	2	—	—	—	—
167	36	14	14	40	185 7	Good	I	Sound	—	2	—	—	—	—
168	37	13	14	34	142 8	Good	I	Slightly putrefied all down the back bone	—	2	—	—	—	—
169	49	20	19	51	168 4	Branded	I	Very slightly heated grain all along back bone	—	1	1	—	—	—
170	54	22	22	62	181 8	Badly branded	II	Badly putrefied all down the back bone	—	—	1	1	—	—
171	41	16	15	42	180 0	Badly worm eaten	II	Putrefied all down the back-bone	—	2	—	—	—	—
172	42	16	16	44	175 0	Good	I	Slightly heated all along the back bone	—	2	—	—	—	—
173	36	13	13	37	184 6	Good	II	Slightly heated all along the back bone	—	—	2	—	—	—
174	29	11	10	28	180 0	Branded	I	Sound very badly branded	—	—	2	—	—	—
175	39	15	16	41	156 2	Good	I	Sound	—	2	—	—	—	—

General Remarks on Dry State —Very bright hair No signs of hair slip, good condition Dark yellow flesh, slightly worm-eaten, otherwise look sound

General Remarks on Pelt State —Practically all heated and putrefied down the back-bone as though they had been dried out over a pole This defect spoilt the cure completely

DRY SEASON. EXPERIMENT D1F (III)

No of hide	Weight Wet	Weight Dry	P T C Dry	P T C pelt weight	Per centage gain	Remarks on hide in dry state	Selection of hide in dry state	Remarks on pelt in limed state	Lime-yard selection of bends					
									III	IV	V	Scab	Cut	Rotten
189	32	13	13	34	161 5	Good	I	Slightly putrefied round tail	—	2	—	—	—	—
190	56	22	23	60	160 8	Good	I	Sound, poor flay	—	2	—	—	—	—
191	37	14	15	38	153 3	Good	I	Badly putrefied flesh side	—	—	—	2	—	—
192	40	15	16	41	154 2	Good	I	Very badly putrefied grain	—	—	2	—	—	—
193	47	18	19	52	173 0	Worm eaten	II	Badly putrefied blistered grain	—	—	—	2	—	—
194	30	11	11	30	172 7	Good	I	Putrefied flesh blistered grain	—	1	1	—	—	—
195	45	17	15	43	186 6	Badly worm eaten	II	Badly heated grain, worm eaten	—	—	2	—	—	—
196	45	19	19	48	152 6	Good	I	Very badly putrefied from flesh side	—	—	—	2	—	—
197	30	11	12	31	158 3	Good	I	Very badly putrefied, almost rotten	—	—	—	2	—	—
198	44	17	13	46	253 8	Good	I	Very badly putrefied, blistered grain	—	1	1	—	—	—
199	38	15	16	37	131 2	Good	I	Absolutely rotten	—	—	—	—	—	2
200	32	11	11	30	172 7	Good	I	Very badly putrefied from flesh side	—	—	—	2	—	—

General Remarks on Dry State.—Very nice bright hair, no signs of hair slip Very dry condition Darkish yellow cure Look as though should work sound

General Remarks on Pelt State.—Very badly heated grain and putrefied, many from the flesh side A very poor cure

DRY SEASON. EXPERIMENT D1F (IV)

No of hide	Weight Wet	Weight Dry	P T C Dry	P T C pelt weight	Per centage gain	Remarks on hide in dry state	Selection of hide in dry state	Remarks on pelt in limed state	Lime-yard selection of bends.					
									III	IV	V	Scab	Cut	Rotten.
213	54	20	22	55	150.0	Good	I	Slightly heated badly branded	—	1	1	—	—	—
214	29	11	11	28	154.5	Badly branded	III	Sound but worm-eaten	—	2	—	—	—	—
215	44	17	17	43	152.9	Good	I	Slightly heated	—	2	—	—	—	—
216	41	18	16	43	168.7	Slightly worm-eaten	II	Slightly heated, worm-eaten	—	1	1	—	—	—
217	43	18	17	45	164.7	Branded	II	Badly heated all over	—	—	—	2	—	—
218	42	17	17	43	152.9	Badly branded	III	Badly heated	—	—	2	—	—	—
219	35	13	13	34	161.5	Good	II	Sound but worm-eaten	—	2	—	—	—	—
220	41	17	17	40	135.2	Good	I	Slightly heated	—	—	—	—	2	—
221	38	15	15	36	140.0	Good	I	Slightly heated, worm-eaten	—	2	—	—	—	—
222	47	19	20	50	150.0	Slightly worm-eaten	II	Heated grain	—	—	2	—	—	—
223	42	19	18	45	150.0	Good	I	Slightly heated	—	—	2	—	—	—
224	40	16	16	40	175.0	Badly branded	III	Badly heated and cracked	—	1	1	—	—	—
225	51	21	21	51	142.7	Branded	II	Slightly heated, stabbed	—	—	—	—	2	—

General Remarks on Dry State.—Look very good Very different from W1F (IV) Bright hair dark yellow cure, no signs of hair slip

General Remarks on Pelt State.—Mostly slightly heated, also worm-eaten Twenty five per cent badly heated

DRY SEASON. EXPERIMENT D1F (v)

No. of hide.	Weight. Wet.	Weight Dry	P.T.C. Dry	P.T.C pelt weight.	Percentage gain.	Remarks on hide in dry state.	Selection of hide in dry state.	Remarks on pelt in limed state.	Lime-yard selection of bends.					
									III.	IV.	V.	Scab.	Cut.	Rotten.
239	64	27	27	76	181·5	Slightly worm-eaten	II	Sound but worm-eaten	—	1	1	—	—	—
240	49	20	24	49	104·1	Good	I	Sound, worm-eaten	—	2	—	—	—	—
241	48	20	19	52	160·0	Good	I	Slightly heated, worm-eaten	—	—	2	—	—	—
242	43	17	17	43	153·0	Good	I	Slightly heated, stabbed	—	2	—	—	—	—
243	39	16	16	39	143·1	Good, branded	II	Sound, stabbed, bad flay	—	—	—	—	2	—
244	58	24	24	58	141·6	Good	I	Slightly heated	—	2	—	—	—	—
245	63	25	25	66	164·0	Badly branded	III	Heated, worm-eaten	—	1	1	—	—	—
246	62	25	25	60	140·0	Good	I	Sound but worm-eaten	—	2	—	—	—	—
247	61	26	25	62	138·0	Good	I	Slightly heated, worm-eaten	—	2	—	—	—	—
248	53	21	20	51	143·0	Worm-eaten	III	Slightly heated	—	2	—	—	—	—
249	46	19	18	47	147·0	Good	I	Sound but badly branded	—	—	2	—	—	—
250	35	12	13	29	141·6	Small brands	II	Slightly heated, badly branded	—	—	2	—	—	—

General Remarks on Dry State.—Appear very good, no difference between D1F (iv) and D1F (v). Bright hair, dark yellow cure, very good condition. Look as though should work sound. A very different article from W1F (v).

General Remarks on Pelt State.—On the whole very sound, some very slightly heated grain, also worm-eaten. Mostly badly branded.

DRY SEASON. EXPERIMENT D6C (1)

No of hide	Weight Wet	Weight Dry	P T C Dry	P T C pelt weight	Per centage gain	Remarks on hide in dry state	Selection of hide in dry state	Remarks on pelt in limed state	Lime yard selection of bends.					
									III	IV	V	Scab	Cut	Rotten.
263	58	23	20	54	170 0	Badly branded	III	Sound badly branded, poor flay	—	—	—	—	2	—
264	49	18	17	47	176 5	Badly branded all over	III	Sound, badly branded, poor flay	—	—	—	—	2	—
265	44	16	16	41	156 2	Good	I	Sound very badly branded	—	—	2	—	—	—
266	48	18	17	48	182 4	Good	I	Sound, bad flay	—	—	—	—	2	—
267	29	10	10	25	150 0	Good	I	Sound	—	2	—	—	—	—
268	49	19	18	49	172 2	Good	I	Sound bad flay	—	—	—	—	2	—
269	48	17	16	49	206 3	Badly branded	II	Sound, badly branded poor flay	—	—	—	—	2	—
270	44	15	14	39	178 6	Badly branded	III	Sound worm-eaten bad flay	—	1	—	1	—	—
271	56	22	21	56	166 6	Good	I	Sound, bad flay	—	2	—	—	—	—
272	44	16	16	41	156 2	Stabbed	II	Sound, bad flay	—	—	—	—	2	—
273	45	16	16	42	162 5	Good	I	Sound, bad flay	—	2	—	—	—	—
274	40	15	14	37	164 3	Good	I	Sound bad flay	—	—	—	—	2	—
275	45	15	15	43	186 6	Side branded	II	Sound, bad flay	—	—	—	—	2	—

General Remarks on Dry State —Bright hair very clean cure, rather darkish green. No signs of hair slip Should work fairly sound

General Remarks on Pelt State —A very sound lot of hides, no signs of heated grain All badly gouged like " Butcher Type," and practically all badly branded

DRY SEASON. EXPERIMENT D6C (ii)

No of hide.	Weight Wet.	Weight Dry	P.T C Dry	P T C pelt weight	Per centage gain	Remarks on hide in dry state	Selection of hide in dry state	Remarks on pelt in limed state	Lime-yard selection of bends.					
									III	IV	V	Scab	Cut.	Rotten
289	45	16	16	44	175·0	Good	I	Slightly putrefied along back-bone	—	1	1	—	—	—
290	46	16	15	44	193·3	Slightly worm-eaten	I	Sound, bad flay	—	—	—	—	2	—
291	41	19	14	36	157·1	Good	I	Badly putrefied along back-bone, bad flay	—	—	—	—	2	—
292	56	22	21	56	166·6	Stabbed	II	Heated down back-bone	—	—	—	—	2	—
293	40	13	14	36	157·1	Side branded	II	Slightly heated along back-bone	—	—	—	—	2	—
294	46	16	16	44	175·0	Stabbed, worm-eaten	II	Heated all along back-bone	—	2	—	—	—	—
295	48	17	17	46	170·5	Good, side branded	II	Sound, bad flay	—	—	—	—	2	—
296	39	14	13	38	192·3	Badly branded	III	Sound, badly branded, bad flay	—	—	—	—	2	—
297	53	20	19	53	178·9	Badly branded all over	III	Sound, bad flay	—	—	—	—	2	—
298	36	14	13	36	176·9	Good	I	Sound, bad flay	—	—	—	—	2	—
299	64	20	20	56	180·0	Badly branded	III	Badly putrefied all along back-bone	—	—	—	—	2	—
300	42	18	16	48	200·0	Badly branded	III	Very slightly heated along back-bone	—	—	—	—	2	—

General Remarks on Dry State —Not quite so bright, dirty on hair side and slightly duller, otherwise quite good Very dry condition, no signs of hair slip Very badly branded

General Remarks on Pelt State —Quite a sound lot of hides, except where heated and putrefied down the back-bone in a straight line as though they had been dried touching something Badly gouged and mostly badly branded

DRY SEASON. EXPERIMENT D6C (III)

No of hide	Weight Wet	Weight Dry	P T C Dry	P T C pelt weight	Per centage gain	Remarks on hide in dry state	Selection of hide in dry state	Remarks on pelt in limed state.	Lime-yard selection of bends.					
									III	IV	V	Scab	Cut	Rotten.
313	45	14	15	41	173 3	Badly branded	III	Badly putrefied, blistered grain	—	—	—	2	—	—
314	46	15	16	45	181 2	Good	I	Badly putrefied, blistered grain	—	—	—	1	1	—
315	34	16	12	31	165 8	Small brands	II	Badly putrefied, blistered grain	—	—	2	—	—	—
316	49	17	17	48	182 3	Badly branded	III	Slightly heated grain, badly branded	—	—	—	—	2	—
317	37	12	13	36	176 9	Branded	II	Sound badly branded, bad flay	—	—	—	—	2	—
318	49	17	16	46	187 5	Ticky, branded	II	Sound, bad flay	—	—	—	—	2	—
319	36	12	12	36	200 0	Stabbed, worm-eaten	II	Sound, badly branded	—	—	—	—	2	—
320	45	15	15	40	166 6	Slight hair slip	II	Slightly heated, bad flay	—	—	—	—	2	—
321	62	23	24	65	170 8	Good	I	Sound, bad flay	—	—	—	—	2	—
322	49	15	15	46	206 6	Good	I	Slightly heated grain bad flay	—	—	—	—	2	—
323	53	17	17	51	200 0	Stabbed, worm-eaten	II	Slightly heated grain, bad flay	—	—	—	—	2	—
324	50	16	16	48	200 0	Very slight hair slip	II	Slightly heated grain all over	—	—	—	—	2	—
325	51	17	18	53	194 4	Stabbed	II	Badly putrefied, blistered grain	—	—	1	1	—	—

General Remarks on Dry State —Quite a bright lot, very dry condition Many stabbed and worm-eaten, flesh and grain Look as though they should work fairly sound

General Remarks on Pelt State —Practically all slightly heated, some very badly putrefied and blistered Badly gouged and mostly branded. Not nearly so good as D6C (IV)

DRY SEASON. EXPERIMENT D6C (iv)

No of hide	Weight Wet	Weight Dry	P T C Dry	P T C pelt weight	Per centage gain	Remarks on hide in dry state	Selection of hide in dry state	Remarks on pelt in limed state.	Lime-yard selection of bends					
									III	IV	V	Scab	Cut	Rotten.
339	34	10	11	28	154 5	Good	I	Sound, bad flay	—	—	—	—	2	—
340	46	16	17	45	164 7	Good	I	Sound, bad flay	—	—	—	—	2	—
341	44	16	16	45	181 2	Good	I	Sound, bad flay	—	—	—	—	2	—
342	38	11	13	37	184 6	Good	I	Sound, bad flay	—	—	—	—	2	—
343	40	14	14	42	200 0	Good	I	Sound, bad flay	—	—	—	—	2	—
344	38	13	13	35	169 2	Good	I	Sound bad flay	—	—	—	—	2	—
345	53	21	19	55	189 4	Badly branded	III	Sound, bad flay	—	—	—	—	2	—
346	41	15	15	40	166 6	Good	I	Sound bad flay	—	—	—	—	2	—
347	65	23	23	65	182 6	Badly branded	III	Cut to ribbons	—	—	—	—	2	—
348	40	14	13	38	192 3	Good	I	Sound, bad flay	—	—	—	—	2	—
349	48	16	16	48	200 0	Badly branded	III	Sound, bad flay	—	—	—	—	2	—
350	50	17	17	48	187 3	Good	I	Sound, bad flay	—	—	—	—	2	—

General Remarks on Dry State —Nice cure, very dry condition, bright hair, no signs of hair slip Some branded

General Remarks on Pelt State —An excellent, sound lot of hides No signs of any heating, but spoilt by bad gouging and branding

DRY SEASON. EXPERIMENT D6C (v)

No. of hide.	Weight. Wet.	Weight. Dry.	P.T.C. Dry.	P.T.C. pelt weight.	Per-centage gain.	Remarks on hide in dry state.	Selection of hide in dry state.	Remarks on pelt in limed state.	Lime-yard selection of bends.					
									III.	IV.	V.	Scab.	Cut.	Rotten.
363	51	18	17	52	205·8	Good	I	Sound	—	—	—	—	—	—
364	38	16	13	36	176·9	Stabbed	II	Sound, bad flay, badly branded	—	—	—	—	2	—
365	53	19	17	52	205·8	Branded	II	Sound, cut to ribbons	—	—	—	—	2	—
366	43	17	16	40	150·0	Badly branded	III	Sound, bad flay	—	—	—	—	2	—
367	42	15	14	41	192·8	Badly branded	III	Sound, badly branded, bad flay	—	—	—	—	2	—
368	45	17	16	45	181·2	Badly branded	II	Sound, bad flay	—	—	—	—	2	—
369	45	17	16	44	175·0	Badly branded	III	Sound, badly branded	—	—	—	—	2	—
370	40	15	13	36	176·9	Badly branded	III	Sound, bad flay	—	—	—	—	2	—
371	59	22	21	56	161·9	Badly branded	III	Sound, badly branded, bad flay	—	—	—	—	2	—
372	47	15	15	48	220·0	Badly branded	III	Sound, bad flay	—	—	—	—	2	—
373	43	16	14	45	221·4	Badly branded	III	Sound, bad flay	—	—	—	—	2	—
374	55	20	20	56	180·0	Good	I	Sound, bad flay	—	—	—	—	2	—
375	37	12	12	32	166·6	Good	I	Sound, cut to ribbons	—	—	—	—	2	—

General Remarks on Dry State.—Bright hair, very good condition, but badly branded. No signs of hair slip. Very different from the wet-season cure (v).

General Remarks on Pelt State.—Very sound pelt, no signs of heated grain or putrefaction. All badly gouged in removing the fat. Mostly badly branded. A very good cure, the very opposite of the wet-season cures (v).

DRY SEASON. EXPERIMENT D6F (i)

No. of hide.	Weight. Wet.	Weight. Dry.	P.T.C. Dry.	P T C. pelt weight	Per-centage gain.	Remarks on hide in dry state.	Selection of hide in dry state.	Remarks on pelt in limed state.	Lime-yard selection of bends.					
									III.	IV.	V.	Scab.	Cut.	Rotten.
389	44	20	18	46	155·5	Good	I	Sound, badly grease-marked	—	—	2	—	—	—
390	48	21	19	53	178·9	Stabbed, badly branded	III	Sound, grease-marked	—	—	2	—	—	—
391	52	21	19	55	189·4	Good	I	Sound	—	2	—	—	—	—
392	41	16	15	44	193·3	Good	I	Sound	—	2	—	—	—	—
393	41	18	17	46	170·5	Good	I	Sound, bad flay	—	2	—	—	—	—
394	47	19	15	46	206·6	Good	I	Sound, grease-marked	—	1	—	—	1	—
395	51	20	19	54	184·2	Side brands, worm-eaten	II	Sound, bad flay	—	2	—	—	—	—
396	41	18	16	44	175·0	Good	I	Sound, grease-marked	—	—	—	—	2	—
397	52	22	21	55	161·9	Good	I	Sound, bad flay	—	—	—	—	2	—
398	30	11	10	28	180·0	Good	I	Sound, bad flay	—	2	—	—	—	—
399	45	19	19	48	152·6	Good	I	Sound, bad flay	—	—	—	—	2	—
400	48	20	19	53	178·9	Small brands	II	Sound, bad flay	—	—	—	—	2	—

General Remarks on Dry State.—Very bright hair, clean lot, good condition. Look very sound. Rather greasy.

General Remarks on Pelt State.—Very sound lot of hides. No signs of heated grain. Many grease-marked. Badly branded and poor flay.

Dry Season. Experiment D6F (ii)

No of hide	Weight Wet	Weight Dry	P T C Dry	P T C pelt weight	Per-centage gain	Remarks on hide in dry state	Selection of hide in dry state	Remarks on pelt in limed state	Lime-yard selection of bends.					
									III.	IV	V.	Scab	Cut.	Rotten.
413	42	15	17	44	158·8	Badly branded	II	Sound, grease-marked	—	2	—	—	—	—
414	50	19	19	53	178·9	Good	I	Sound	—	2	—	—	—	—
415	36	13	13	36	176·9	Good	I	Sound, bad flay	—	2	—	—	—	—
416	39	13	14	40	185·7	Branded	II	Sound, badly branded	—	2	—	—	—	—
417	43	17	17	44	158·8	Slightly worm-eaten	II	Sound, badly grease-marked	—	2	—	—	—	—
418	45	16	17	44	158·8	Badly branded	III	Sound, grease-marked, worm-eaten	—	2	—	—	—	—
419	36	12	13	38	192·3	Badly branded	III	Sound, bad flay	—	1	1	—	—	—
420	44	16	16	50	212·5	Good	II	Sound, badly branded, poor flay	—	—	2	—	—	—
421	40	15	15	42	180·0	Badly branded	III	Sound, poor flay	—	2	—	—	—	—
422	51	18	19	54	184·2	Good	I	Sound	—	1	1	—	—	—
423	55	20	20	54	170·0	Badly branded	III	Sound, poor flay	—	1	1	—	—	—
424	55	21	22	57	159·0	Good	II	Sound, grease-marked	—	—	—	—	2	—
425	36	13	13	40	207·6	Side branded	II	Very slightly heated where grease-marked	—	1	1	—	—	—

General Remarks on Dry State.—Very bright-looking lot, good condition. No signs of hair slip, should work sound

General Remarks on Pelt State.—Very sound pelt all through, a very good cure Poorly flayed and mostly badly branded

DRY SEASON. EXPERIMENT D6F (iii)

No of hide	Weight Wet	Weight Dry	P T C Dry	P T C pelt weight	Per centage gain	Remarks on hide in dry state	Selection of hide in dry state	Remarks on pelt in limed state	Lime-yard selection of bends					
									III	IV	V	Scab	Cut	Rotten.
439	45	18	18	49	172·2	Side brands	II	Sound, badly branded	—	—	—	—	2	—
440	36	15	13	38	192·3	Good	I	Sound	—	2	—	—	—	—
441	48	20	19	53	178·9	Good	I	Sound, badly branded	—	2	—	—	—	—
442	49	20	19	53	178·9	Good	I	Sound	—	2	—	—	—	—
443	48	20	19	49	157·9	Good	I	Sound, poor flay	—	—	—	—	2	—
444	40	15	15	41	173·3	Good	I	Sound	—	2	—	—	—	—
445	30	12	10	28	180·0	Badly branded	III	Sound, badly branded	—	2	—	—	—	—
446	46	19	18	48	166·6	Good	I	Sound	—	2	—	—	—	—
447	45	19	18	48	166·6	Good	I	Sound, bad flay	—	—	—	—	2	—
448	43	18	18	46	155·5	Badly branded	III	Sound, badly branded	—	—	2	—	—	—
449	50	20	20	55	175·0	Good	I	Sound, grease-marked	—	1	—	—	1	—
450	49	20	20	51	155·0	Badly branded	III	Sound, very badly branded	—	—	2	—	—	—

General Remarks on Dry State—Quite nice cure, good bright hair, good condition Should turn out sound

General Remarks on Pelt State—Very sound lot of hides, no signs of heated grain Very much better than any of W1C (iii), W6C (iii), W1F (iii) or W6F (iii). Rather poor flay and mostly badly branded

DRY SEASON. EXPERIMENT D6F (iv)

No. of hide.	Weight. Wet.	Weight Dry.	P.T.C. Dry.	P.T.C. pelt weight.	Per-centage gain.	Remarks on hide in dry state.	Selection of hide in dry state.	Remarks on pelt in limed state.	Lime-yard selection of bends.					
									III.	IV.	V.	Scab.	Cut.	Rotten.
463	41	17	17	40	135·2	Good	I	Sound, grease-marked, badly branded	—	2	—	—	—	—
464	40	15	14	41	192·8	Worm-eaten	II	Sound, slightly grease-marked	—	2	—	—	—	—
465	39	14	13	35	169·2	Badly branded	III	Sound, badly branded	—	—	—	2	—	—
466	44	19	17	47	176·4	Slightly worm-eaten	II	Sound, poor flay	—	2	—	—	—	—
467	50	20	19	53	178·9	Badly branded, worm-eaten	III	Sound	—	2	—	—	—	—
468	47	20	18	49	172·4	Small brands	II	Sound, poor flay	—	1	1	—	—	—
469	40	16	16	38	137·5	Good	I	Sound	—	2	—	—	—	—
470	42	18	18	47	161·1	Badly branded	III	Sound, badly branded	—	2	—	—	—	—
471	36	14	14	38	171·4	Good	I	Sound	—	2	—	—	—	—
472	35	15	14	39	178·5	Branded	II	Sound, badly branded	—	—	2	—	—	—
473	40	16	15	36	140·0	Good	I	Sound, bad flay	—	—	2	—	—	—
474	34	13	12	33	175·0	Stabbed	II	Sound	—	2	—	—	—	—
475	39	16	15	39	160·0	Good	I	Sound	—	2	—	—	—	—

General Remarks on Dry State.—Quite good bright lot, no signs of hair slip, very dry condition. Badly branded. Should work sound.

General Remarks on Pelt State.—A very sound lot of hides. No signs of heated grain or putrefaction. Some poor flay and grease-marked. Mostly badly branded.

DRY SEASON. EXPERIMENT D6F (v)

No of hide	Weight Wet	Weight Dry	P T C Dry	P T C pelt weight	Percentage gain	Remarks on hide in dry state	Selection of hide in dry state	Remarks on pelt in limed state	Lime yard selection of bends.					
									III	IV	V	Scab	Cut.	Rotten.
489	30	11	11	28	154.5	Badly branded, stabbed, worm-eaten	III	Sound, worm-eaten	—	—	2	—	—	—
490	35	13	13	34	161.5	Slight hair slip	II	Slightly heated grain all over	—	2	—	—	—	—
491	36	15	13	32	146.1	Hair slip, stabbed	III	Slightly heated grain in patches	—	2	—	—	—	—
492	48	20	17	51	200.0	Worm-eaten	II	Sound, worm-eaten	—	2	—	—	—	—
493	32	13	12	31	158.3	Slight hair slip	II	Slightly heated grain round tail	—	—	2	—	—	—
494	38	16	15	39	160.0	Branded, worm-eaten	II	Sound, worm-eaten	—	2	—	—	—	—
495	42	16	15	41	173.3	Very bad, worm-eaten, hair slip	III	Badly heated grain all over	—	—	2	—	—	—
496	44	16	15	45	200.0	Bad hair slip, worm-eaten	III	Slightly heated grain, worm-eaten	—	—	2	—	—	—
497	33	13	12	33	175.0	Worm, very bad hair slip, branded	III	Very slightly heated	—	2	—	—	—	—
498	40	16	15	39	160.0	Very bad hair slip, worm-eaten	III	Badly heated all over	—	—	2	—	—	—
499	46	19	17	47	176.4	Very bad hair slip	III	Slightly heated grain	—	—	2	—	—	—
500	33	12	12	28	133.3	Very bad hair slip, worm-eaten	III	Badly heated grain, worm-eaten	—	—	—	2	—	—

General Remarks on Dry State.—By far the most dangerous-looking lot of the dry-season cure. Practically all with bad hair slip, which rather suggests that the fat has something to do with it as D6C (v) were very good. Mostly badly worm-eaten, quite good condition.

General Remarks on Pelt State.—Practically all hides heated on the grain, mostly all over. Grain very tender where not heated. Certainly better than the wet season, but very poor. Many worm-eaten, branded and poor flay.

APPENDIX II

RESULTS OF TANNING TRIALS MADE BY MESSRS. W. L. INGLE, LTD., WITH HIDES FROM DRY-SEASON EXPERIMENTS

This firm tanned half the consignment of hides from the Dry-season Experiments, viz.: 250 hides, consisting of 20 batches of 12 or 13 hides each, representing the 20 experiments carried out in this season.

REPORT ON HIDES IN DRY CONDITION

	Nos.	
D1C (i).	1–12.	Very good fresh pelt. Mixed grain selection. All pelt looks good.
D1C (ii).	26–38.	Good fresh pelt. Grain selection mixed. Three hides with patches on flesh side as if water had stood there.
D1C (iii).	51–62.	Very good appearance. Fresh and clean. A few transparent spots on flesh side.
D1C (iv).	76–88.	Very good fresh hides. Mixed selection. More transparent spots than previous lot.
D1C (v).	101–112.	Good fresh hides. Mixed grain selection. More transparent patches.
D1F (i).	126–138.	Lots of flesh and fat. Fresh hides. No apparent damage owing to presence of fat. Some putrefaction around base of tail.
D1F (ii).	151–162.	Large amount of fat, especially in ribs, but no apparent damage.
D1F (iii).	176–188.	Plenty of fat and flesh left on in butt and ribs, but no damage as far as one can see. Mixed grain selection.
D1F (iv).	201–212.	Large amounts of fat and flesh, but no apparent damage due to same. Rather a lot of insect damage.

	Nos	
D1F (v).	226–238.	Lots of fat and flesh left on. Hair slip in three hides, but no other damage.
D6C (i).	251–262.	Good fresh hides, clean and apparently free from damage. A few transparent patches.
D6C (ii).	276–288.	Fresh clean pelt with no damage.
D6C (iii).	301–312.	Clean and fresh hides. Insect damage.
D6C (iv).	326–338.	Fresh hides well cleaned. Insect damage.
D6C (v).	351–362.	Fresh hides. Insect damage. Hair slip in a few cases.
D6F (i).	376–388.	Fat and flesh in plenty, but no apparent damage.
D6F (ii).	401–412.	Lot of fat and flesh. Grain damage by insect. Some hair slip in region of tail.
D6F (iii).	426–438.	Insect damage more pronounced. Lot of fat and flesh, but no damage seems to be shown from them.
D6F (iv).	451–462.	Hair slip on most hides. Insect damage.
D6F (v).	476–488.	Hair slip bad on most of the hides. Much insect damage.

REPORT ON PELTS IN LIMED STATE

D1C (i).	All good. No damage.
D1C (ii).	One side with a small patch of putrefaction. Others all good.
D1C (iii).	Three good sides. Two sides badly putrefied. Eight sides with small patches of putrefaction. Thirteen sides with bad grain slip.
D1C (iv).	Five sides putrefied in brands. Seven sides with grain slip. Twelve good sides.
D1C (v).	All good sides.
D1F (i).	Two sides which show slight signs of putrefaction. All the rest good.
D1F (ii).	Four sides with putrefaction down straight edge. All rest good.

D1F (iii).	Three sides rotten. Eight sides badly putrefied ; grain slip bad. Twelve good sides.
D1F (iv).	Seventeen good sides. Six sides with putrefied brands. One side with blister in ribs.
D1F (v).	Good sides. Two sides with slight putrefaction in hump.
D6C (i).	All good sides.
D6C (ii).	One side blistered in butt. Eleven sides with grain putrefaction. Fourteen good sides.
D6C (iii).	Fifteen good sides. Eight sides with putrefaction in brands. Two sides with grain slip.
D6C (iv).	Three sides with slight putrefaction. All the rest good.
D6C (v).	All sound good sides.
D6F (i).	Twenty-four good sides. One side with blister in butt. One side grain slip.
D6F (ii).	All good sides except for two with very small area of putrefaction in butt.
D6F (iii).	Three sides with bad grain slip. All rest good.
D6F (iv).	All good sides except for one with grain slip.
D6F (v).	Four sides with slight putrefaction. Two with grain slip. All the rest good.

Two sides for glue out of D1C (iii).
Seven sides for glue out of D1F (iii).

APPENDIX III

REPORT BY DR. D JORDAN LLOYD ON THE LEATHER PREPARED BY THE PENKETH TANNING CO.

Five hundred hides from the Wet Season and 250 hides from the Dry Season had been tanned for the production of sole leather. The bends were inspected at the tannery.

In the following descriptions " grain damage " signifies superficial taint damage on the grain, while " blister damage " is that which completely penetrates the leather.

Wet-season Experiments

W1C (i).	Grain clean, practically no taint damage. Flesh clean.

W1C (ii).	Only three or four bends show slight taint damage on grain, along pole position. Remainder have clean grain and flesh.
W1C (iii).	About 10 per cent. show slight grain damage. Very little taint of flesh side. As good as (ii).
W1C (iv).	Grain on the whole clear. A few very small blister holes. Show but little damage apart from cuts.
W1C (v).	Many bends show slight grain damage, some show blister damage. More taint damage than in (iv).
W1F (i).	Grain damage on a few bends. Flesh good.
W1F (ii).	Nearly every bend shows small areas of grain damage. Flesh good.
W1F (iii).	About 70 per cent. of the bends show blister damage, while most of the remainder show grain damage.
W1F (iv).	Every bend defective, many very bad. Bad grain damage and bad blister damage. The results for this batch were considered to be typical for ordinary " Mombasa " hides.
W1F (v)	At the pelt stage, 20 of the 25 hides in this batch went for glue. See W6F (v).
W6C (i).	Practically free from taint damage on grain. One or two are slightly affected on flesh.
W6C (ii).	Slight damage on a few bends due to taint along pole position, or by the brand marks. Good condition except for cuts.
W6C (iii).	Good condition as (i) and (ii). Slight grain damage on one or two.
W6C (iv).	Similar to (iii).
W6C (v).	About 60 per cent. of bends show grain damage, which is generally slight.
W6F (i).	About 25 per cent. show slight grain damage. Flesh good.
W6F (ii).	Not quite so good as (i). Taint damage along pole position in a few cases. About 40 per cent. of bends show grain damage. Flesh good.
W6F (iii).	No bend free from defect. About 20 per cent. only slightly damaged, the remainder show blister damage.

W6F (iv). Grain damage worse than (iii). Large areas of bad blister damage.

W6F (v). At the pelt stage, 18 hides went for glue. Only 14 bends were obtained as finished leather from W1F (v) and W6F (v). These are all very ragged with large holes due to blister.

Note.—All the leather in series W1C and W6C showed knife cuts, due to careless use of the knife in cleaning. The damage to most of the bends was serious.

DRY-SEASON EXPERIMENTS

D1C (i). Good ; a little taint damage on some of the flay marks and brandings.

D1C (ii). Fairly good condition, but not so good as D1F (ii). Some grain damage ; some in pole position.

D1C (iii). Poor lot. Bad grain damage. Much blister damage. At pelt stage one hide went for glue.

D1C (iv). Extensive grain damage, but not much due to blister.

D1C (v). Good lot. Very little grain damage.

D1F (i). Very good lot. Practically no damage of any sort. A few brand marks. Leather looks " fuller " than in C series.

D1F (ii). Generally in good condition, but taint damage along pole position in many cases.

D1F (iii). Bad lot. About 90 per cent. of bends are damaged, grain and blister. At pelt stage one hide went for glue.

D1F (iv). About 50 per cent. of bends are free from taint damage. Remainder show grain and blister damage.

D1F (v). A good lot on the whole. Slight blister and grain damage.

D6C (i). Good condition, but some taint damage on cuts and brands.

D6C (ii). Good lot ; fairly sound, but showing grain damage in pole position.

D6C (iii). About 50 per cent. of bends show slight grain damage.

D6C (iv).	Good condition. Slight grain damage on a few bends.
D6C (v).	Good lot. Slight grain damage, especially along brands. Very severe cuts leading to blister holes in two or three bends.
D6F (i).	Very good lot. Very little grain damage. A few brands.
D6F (ii).	Sound lot, very similar to (i). No damage in pole position observed.
D6F (iii).	Very good lot. Practically free from taint or other damage.
D6F (iv).	Very sound lot, practically free from taint.
D6F (v).	Slight grain damage on every hide. No blister damage. Flesh sound.

Note.—All the leather in series D1C and D6C showed damage due to knife cuts similar to that recorded for W1C and W6C series.

Branding.—All hides, except as noted in the foregoing descriptions, were heavily branded.

APPENDIX IV

REPORT ON THE MICROSCOPICAL EXAMINATION OF THE LEATHER PREPARED BY THE PENKETH TANNING CO.

By the British Leather Manufacturers' Research Association

Photomicrographs were prepared of the corium of the leather. The description of each photomicrograph is followed by a number. These numbers refer to an assessment of quality of the fibre structure in which 12 was taken as the "Highest Quality" figure.

W1C (i).	Angle of weave medium to high, pattern confused, loose and open. Fibre bundles very much split up and showing separation. (6.)
W1C (ii).	Angle of weave low to medium, pattern a little more regular than in W1C (i), but very open. Fibre bundles very much split up and showing separation. (6.)

W1C (iii).	Angle of weave medium to high, pattern fairly regular and compact. Fibre bundles full and satisfactorily split up. (9.)
W1C (iv).	Angle of weave medium to high, pattern regular but a little open in places. Fibre bundles moderately full and satisfactorily split up. (8.)
W1C (v).	Angle of weave medium to high, pattern fairly regular and compact. Fibre bundles varying somewhat in thickness, splitting up satisfactorily. (9.)
W1F (i).	Angle of weave low to medium, pattern fairly regular and compact. Fibre bundles full, splitting up satisfactory. (8.)
W1F (ii).	Angle of weave medium, pattern regular and compact. Fibre bundles moderately full, and very considerably split up, slight signs of separation. (9.)
W1F (iii).	Angle of weave low, pattern irregular and very loose and open. Fibre bundles thin, very much split up and showing separation. (5.)
W1F (iv).	Angle of weave high, pattern regular and compact. Fibre bundles full and satisfactorily split up. (10.)
W1F (v).	Angle of weave high, pattern a little irregular, but very compact. Fibre bundles full and satisfactorily split up, but have a rather crinkled appearance. (9.)
W6C (1).	Angle of weave low to medium, pattern rather irregular, not very compact. Fibre bundles thin, considerable splitting up leading to slight separation. (7.)
W6C (ii).	Angle of weave low, pattern rather irregular and open. Fibre bundles thin, considerable splitting up with some separation. (6.)
W6C (iii).	Angle of weave medium to high, pattern confused and rather loose. Fibre bundles vary very much indeed in thickness, they are not very much split up. (7.)
W6C (iv).	Angle of weave high, pattern fairly regular and compact. Fibre bundles very full, satisfactorily split up. (9.)

W6C (v).	Angle of weave medium to high, pattern fairly regular, rather open. Fibre bundles moderately full, slight tendency to separation. (8.)
W6F (i).	Angle of weave low to medium, pattern irregular and loose. Fibre bundles thin, considerably split up and with a tendency to separation. (6.)
W6F (ii).	Angle of weave medium to high, pattern irregular. Fibre bundles very thin, considerable splitting up and slight tendency to separation. (7.)
W6F (iii).	(Thick section, would not cut well). Angle of weave medium to high, pattern fairly regular. Compact. Fibre bundles full, seem to be satisfactorily split up. (8.)
W6F (iv).	(Thick section, would not cut well.) Angle of weave medium to high, pattern irregular. Fibre bundles varying a good deal in thickness and not very tightly packed together. Splitting up seems satisfactory. (7.)
D1C (i).	Angle of weave medium to high pattern, not very regular. Fibre bundles on the thin side, very considerably split up, and showing a slight degree of separation. (8.)
D1C (ii).	Angle of weave medium to high. Pattern more regular and compact than in D1C (i) and fibre bundles fuller and not quite so much split up. (8.)
D1C (iii).	Angle of weave medium, pattern fairly regular, not quite so compact as D1C (ii), and fibre bundles not quite so boldly outlined. (8.)
D1C (iv).	(Rather thick section.) Angle of weave medium, pattern regular and compact. Fibre bundles full and satisfactorily split up. (10.)
D1C (v).	Angle of weave high, weave pattern regular and compact. Fibre not as full as in D1C (iv), but otherwise satisfactory. (10.)
D1F (i).	Angle of weave medium to high. Weave pattern not very regular and rather loose. Fibre bundles rather thin, very much split up and showing some separation. (6.)

D1F (ii).	Angle of weave medium to high, pattern not very regular, fairly compact. Fibre moderately full and satisfactorily split up. (9.)
D1F (iii).	Angle of weave high, weave pattern regular but open. Fibre bundles full, considerable splitting up and signs of separation. (7.)
D1F (iv).	Angle of weave almost vertical, pattern regular and compact. Fibre bundles very full, not very boldly outlined nor very much split up. (11.)
D1F (v).	Angle of weave low to medium, pattern fairly regular, compact. Fibre bundles thin, satisfactorily split up. (8.)
D6C (i).	Angle of weave high to medium, pattern rather irregular. Fibre bundles rather thin and not very much split up. (8.)
D6C (ii).	Angle of weave high, almost perpendicular. Pattern compact on the whole but rather confused. Fibre bundles full and satisfactorily split up. (9.)
D6C (iii).	Angle of weave high, pattern compact and fairly regular. Fibre bundles full and satisfactorily split up, have slightly crinkled appearance. (9.)
D6C (iv).	Angle of weave low to medium, pattern fairly regular but rather open. Fibre bundles fairly full, much split up and showing some separation. (7.)
D6C (v).	Angle of weave medium to high, pattern fairly regular but rather open. Fibre bundles thin, much split up, and showing some separation. (8.)
D6F (i).	Angle of weave low to medium, pattern fairly regular and compact. Fibre bundles rather thin, but boldly outlined and satisfactorily split up. Very slight separation. (8.)
D6F (ii).	Angle of weave medium to high, pattern fairly regular, compact. Fibre bundles boldly outlined and satisfactorily split up. (10.)

D6F (iii). Angle of weave high, pattern fairly regular and compact. Fibre bundles vary a good deal in thickness. They are satisfactorily split up, but show very slight separation. (9.)

D6F (iv). Angle of weave very high, pattern rather irregular, on the whole compact, but one or two open spaces. Fibre bundles rather thin and crinkled, satisfactorily split up. (8.)

D6F (v). Angle of weave medium to high, pattern fairly regular. The fibre bundles are rather thin and perhaps a little too much split up. (9.)

ASSESSMENT OF QUALITY FROM MICROSCOPICAL EXAMINATION OF CORIUM

VALUES GIVEN TO THE LEATHER FROM EACH EXPERIMENT, BASED ON FIBRE STRUCTURE, WITH 12 AS THE MAXIMUM

Experiment	(i)	(ii)	(iii)	(iv)	(v)
D1C	8	8	8	10	10
D6C	8	9	9	7	8
D1F	6	9	7	11	8
D6F	8	10	9	8	9
W1C	6	6	9	8	9
W6C	7	6	7	9	8
W1F	8	9	5	10	9
W6F	6	7	8	7	No spec

Average for dry-season hides 8 5
Average for wet-season hides 7 6

This examination has shown that all the methods of drying yield good leather apart from localised damage. The leather from the " dry-season " hides is better on the whole in each method of drying than that from the wet-season hides. As regards the condition of the fibre structure of the corium, Method (iv), which appeared for the most part to give such bad results in the pelt state at Penketh, gives surprisingly good results in most instances both in dry- and wet-season hides. The results with Method (v) are also surprisingly good considering the Penketh report on the state of the Method (v) hides in the pelt condition. The report from Penketh is based mainly on the condition of grain and flesh. The microscopical examination shows that even where there has been bad blister, the damage is local. Bad methods are bad because they encourage putrefaction, not because they actually directly cause damage to the fibres.

APPENDIX V

NUMBER OF DAYS REQUIRED FOR THE DRYING OF THE HIDES

Method of drying	Wet Season				Dry Season.			
	One hour delay		6 hours' delay		One hour delay		6 hours' delay.	
	C	F	C	F	C	F	C	F.
(i)	6, 8 or 11	6, 8 or 16	13	6	6	7 or 8	5	8
(ii)	7	1[1] to 6	5	8	3	8	4 or 5	8
(iii)	9	7	4	6	4	7 or 8	6 or 7	5
(iv)	4	19	4	11 Very heavy rains	4	4 or 6	5, 6 or 7	6
(v)	12	12 Very heavy rains Most days under water	10	11 Damp ground	5	7	8 or 9	7

[1] This would appear to be an error

APPENDIX VI

SUMMARY OF METEOROLOGICAL RECORDS OF THE EXPERIMENTS IN KENYA

—	Season.	8 a m.			Noon.			4 p.m.			Absolute readings during night and day.	
		Min.	Max.	Mean.	Min.	Max.	Mean.	Min.	Max.	Mean.	Min.	Max.
Temperature, ° F.	Wet	58	72	64	60	76	70	62	77	70	50	77
	Dry	58	71	65	63	80	74	62	84	73	44	84
Humidity, *per cent.*	Wet	50	100	83	51	95	70	51	91	72		
	Dry	58	97	79	35	97	54	28	96	55		

The observations in the Wet Season were taken from May 1 to June 17, and those in the Dry Season from October 7 to December 20, in 1932.

APPENDIX VII

SUMMARY OF BLISTER AND TAINT DAMAGE IN THE HIDES

Method of drying.	Damage.	Wet Season.				Dry Season.			
		One hour.		6 hours.		One hour.		6 hours.	
		C.	F	C	F.	C.	F	C.	F.
(i) .	Blister	None	None	None	None	None	None	None	Very slight
	Taint	Trace	Slight	Trace	Slight	Trace	Trace	Trace	Very slight
(ii) .	Blister	None	None	None	None	None	None	Very slight	None
	Taint	Trace	Slight	Trace	Slight	Very slight	Slight	Bad	Trace
(iii) .	Blister	None	Very bad	None	Very bad	Very bad. 4 sides for glue	Very bad. 9 sides for glue	Bad	None
	Taint	Very slight	Very bad	Very slight	Very bad	Very bad	Very bad	Bad	Very slight
(iv) .	Blister	Very slight	Very bad	None	Very bad	Bad	Bad	None	None
	Taint	Slight	Very bad	Slight	Very bad	Very bad	Bad	Trace	Trace
(v) .	Blister	Bad	Extremely bad. 38 sides for glue	Slight	Extremely bad. 36 sides for glue	None	Very slight	Very slight	None
	Taint	Bad	Extremely bad	Bad	Extremely bad	Trace	Very slight	Very slight	Bad

NOTES ON THE POSITION OF THE SILK INDUSTRY IN INDIA

The former importance of the silk industry and trade of India and the recognised suitability of the climate and conditions of labour for the prosecution of sericulture as a commercial undertaking brings India to the front in the consideration of proposals for developing the production of raw silk in Empire countries.

The position has been kept well in mind by the Imperial Institute Advisory Committee on Silk Production throughout its work in this connection and, so far as the circumstances of the case have permitted, the Committee have urged recognition of the great potentialities of India as a silk-producing country and the opportunities offered thereby for the development of British supplies of a commodity in which the Empire, apart from India and Cyprus, is at present without commercial resources. The Indian silk industry has been the subject of much attention by the Committee, which in 1921 published, in connection with the Imperial Institute Indian Trade Enquiry, a Report on Indian Silk which was submitted to the Government of India. The recommendations of the Committee were concerned with economic, industrial and sericultural considerations regarded by the Committee as essential factors in the rehabilitation of the silk industry. It would appear that hitherto circumstances have prevented action being taken in India on the lines suggested by the Committee.

Subsequently, the Committee have dealt with matters arising in connection with the sericultural industries of Kashmir, Madras, etc., and the Committee have been confirmed in their views regarding the capacity of the country as a producer of silk. Recently, the Committee decided to review the present position of sericulture in India and in this connection they were furnished by Sir Harry Lindsay, Trade Commissioner for India in London, who is a member of the Committee, with a series of valuable reports on the position of the silk industries of Mysore State and the Provinces concerned which had been specially obtained by him from India for the purpose. About this time it was announced that the Indian Tariff Board proposed to examine the application made to them for the protection of the Indian sericultural industry and the Committee decided to consider the reports furnished by Sir Harry Lindsay in relation to the information concerning the industry which it was anticipated would be embodied in the Board's report. [This report has now been published (see page 129).]

In view of the interest of the information contained in the reports received by the Trade Commissioner for India it was decided to publish them in the BULLETIN OF THE IMPERIAL INSTITUTE. In printing the documents minor alterations have been made in paragraphing, and occasionally in wording, for convenience of arrangement.

As an introduction it may be mentioned that the Indian sericultural industry is concerned with four main types of silkworm, viz. the mulberry silkworm (*Bombyx mori*), the tasar silkworm (*Antheræa Paphia*), the muga silkworm (*Antheræa assama*) and the eri silkworm (*Attacus ricini*). Of these the mulberry worm is by far the most important.

The rearing of mulberry silkworms is now mainly confined to Mysore State, Kashmir and Jammu State, Bengal, and a few scattered areas in Burma, Assam and the Punjab. The former importance of Bengal as a producer and exporter of silk is a commonplace of the silk trade in this country, as also, unfortunately, is the decline of the industry to a point when export has ceased. Apart from small quantities of good-quality silk from Kashmir, export from India as a whole has also disappeared. Considerable quantities of mulberry silk are nevertheless produced for local consumption and practically the whole output is consumed by the hand-loom weaving industry. The methods of production and handling of Indian silk, except in the case of the Kashmir product, are not such as appeal to the consumers of raw silk in the European and American markets. This state of affairs results mainly from extreme conservatism in regard to the organisation of the industry and the technical processes employed, notably as affecting the reeling of the silk, which is carried out by the most primitive appliances.

In recent years the producing industry has been seriously affected by the increasing imports of raw silk and of thrown silk yarns from China and Japan, and by the rayon (artificial silk) yarns, which are also being used in increasing quantities. These factors are dealt with in the report of the Indian Tariff Board to which reference has already been made.

BENGAL

1. *A Declining Industry.*—The decline in the silk industry of Bengal is manifest from the fact that several European firms of good reputation as business people were compelled to cease their activities, not on account of a rival substitute ousting their product from the field, as was the case with indigo, but owing to the competition of foreign silk. It is true that artificial silk has only very recently entered the market, but openings for this fibre have been found more by the introduction of new lines of articles than by replacing articles for which real silk has so far been used and, it would appear, will always be used. In the market, foreign silk is in much greater abundance than the indigenous Bengal silk, and silk from Indian States and from Provinces in India other than Bengal is being utilised in factories and other places where Bengal silk formerly was exclusively employed.

2. *Mulberry Cultivation and Cocoon Rearing.*—So far as the quality of indigenous cocoons is concerned, considerable time and money have been spent by experts to obtain disease-free " seed " and cocoons. The univoltine variety, although yielding only one crop during the year, gives a thick, long filament and is almost equal to any other variety of silk. The multivoltine variety, although yielding five crops during the year, gives thinner and shorter filaments, which are only suitable for special purposes, for which the best quality of silk is not required, but for which there is a market. The univoltine variety, however, hatches usually in February when the mulberry leaves are insufficient and the climatic conditions are unfavourable. Successful hatchings of the univoltine type, during November, have been recently secured. It is expected that before long an acreage for cultivation of mulberry for rearing this variety of cocoons will increase very substantially. Another improvement is the cultivation of mulberry trees instead of plants, recently undertaken. (Information supplied by the Agricultural Department.)

3. *Defective Reeling.*—A conference of the Director of Industries, Director of Agriculture and the Registrar of Co-operative Societies, Bengal, was held in 1931, to enquire into the question of the decline of the silk industry in Bengal. The conclusion was reached that the reeling of the cocoons was at fault and that this was the primary reason of the decline. It may be mentioned that the plain silk thread is prepared by gathering and twisting together (reeling) several filaments from cocoons steeped in a warm bath. The number of cocoons must be kept constant to secure uniformity of the thread, broken filaments being immediately joined. The country reelers, who sell their silk by weight in hanks, where irregularities of the thread cannot be observed, do not pay attention to this important point, with the result that not only has the reeled silk to pass through the process of re-reeling and cleaning, but a large proportion of thick or thin silk has to be rejected in making the silk weavable. Thus, in spite of the appreciated lustre and tenacity of the fibre, Bengal silk lost the market owing to its unreliability. The country *ghai* for reeling is slow and laborious, and modifications of the reeling plant to secure greater efficiency and yet remain suitable for village workers are desirable. In any case, however, a proper amount of supervision is essential in reeling uniform yarn in quantities. At present, two five-basin domestic reeling plants have been brought over to Bengal from Mysore and a Mysore reeler has been appointed for running the machinery. One of them is being set up at Maldah. The other is successfully running at the Berhampore Silk Weaving Institute, which is also equipped with three Italian power-driven basins. With successful demonstration at the two centres, it is expected that proper reeling will be established throughout the silk districts ; the absence of good reeling is one of the root causes of the decline in the silk industry in Bengal.

4. *Preparation for Weaving.*—For ordinary weaving purposes reeled silk must be twisted together (thrown) into stouter threads, preparatory to weaving. Simple machinery for the process, and power-looms for weaving, are working at the Behampore Silk Weaving Institute for demonstration of the processes. The installation of up-to-date preparatory (throwing) machinery has been sanctioned by Government and will be obtained when funds become available.

5. *Silk Weaving in Factories.*—There are two silk factories in Bengal, both situated in Calcutta. Messrs. Ariff Brothers' firm in North Calcutta is of long standing, and is doing extensive work with silk from other provinces

of Bengal. The other firm, in South Calcutta, viz. the Cooverjee Bhoja Silk Mills, is of recent origin, but is also taking up various kinds of silk weaving, using mostly imported silk.

MADRAS

1. *Extent of the Industry.*—The industry is carried out in a number of districts in the Madras Presidency, the most important being Kollegal taluk of the Coimbatore district. About 11,000 acres are under mulberry, and silkworm rearing is the main subsidiary occupation of the agricultural classes. The average cost of bringing an acre of land under mulberry cultivation is Rs. 15 and the cost of upkeep per year, including the charges for rearing, is about the same. Six or eight leaf pickings are made in a year, the number of rearings in a year varying from six to eight.

2. *Government Silk Farms.*—In order to improve the breed of worms and to produce good disease-free seed cocoons for distribution to silkworm rearers at Kollegal and other district centres, Government have opened three silk farms at Coonoor, Hosur and Palmaner. In addition to these three farms, seed cocoons produced by private rearers in various district sericultural centres of the Madras Presidency are tested and supplied to Kollegal rearers. Further, to encourage the planting of mulberry in suitable areas, Government are distributing cuttings free of charge to those who are willing to take up sericulture. This concession is being taken advantage of by many agriculturists.

3. *Sale of Cocoons.*—No difficulty is experienced in selling cocoons, which are readily bought by reelers. One thousand seed cocoons give about 400 female moths, which yield about 330 layings of disease-free seed. The yield from these is about six maunds of cocoons, the price of one maund of cocoons being Rs. 12.

4. *Reeling.*—Silk rearers do not generally reel silk. A few reelers in each central village own a number of reeling machines of the primitive cottage type and run them.

The process of reeling silk with the present type of appliances and arrangements does not give the necessary twist and uniformity to the silk thread, and though the reelers are skilful, they are not able to reel uniform and flawless threads. Successful demonstrations are given at Kollegal by the Department on an Italian reeling machine provided with arrangements for securing uniform twists and size of threads. The result has been gratifying. One up-to-date reeling filature with forty basins was started by Mr. D. Silva at Mudigundam, Kollegal. This filature is doing satisfactory work. Another filature with five basins was started by a private capitalist and Government have granted him a loan also under the State Aid to Industries Act. Owing, however, to the lack of sustained work on the part of the capitalist, the filature is closed.

5. *Silk-throwing Mill.*—The Department of Industries was successful in inducing a capitalist to set up a modern silk-throwing mill which is doing very useful work. There are 282 spindles working and the out-turn of twisted silk is about 40 lb. (single twist) per day.

6. *Ericulture.*—The Department of Industries is pioneering a new industry described as "Ericulture," based on the eri silkworm. The eri worm feeds on castor leaves, and as it is hardier than the mulberry worm and no taking of life is involved as in mulberry sericulture, which is against Hindu sentiment, it is easier to propagate this industry. There are about 300,000 acres under castor cultivation in the Presidency, chiefly in the Northern Circars, Ceded districts and Central districts and the cultivation now is for seed purposes only. If the castor leaves now wasted could be utilised to rear the Eri worms, a large industry could be built up. Successful experiments have been conducted by the Department at Kuppam in the Chittoor district to rear the worms and spin the cocoons into yarn, and the results have encouraged people to start the industry in several parts of the Presidency. Each acre under castor can produce about 80 to 100 lb. of cocoons in a year, and if all the 300,000 acres under castor is brought under ericulture, the quantity of cocoons produced will be about 30 million lb. This vast quantity needs to be spun into yarn and then marketed, or marketed as cocoons. The Department is now engaged in investigating the possibility of finding the market for the cocoons in several parts of the world and has sent small consignments to America, London, Hamburg and Milan. The Department of Agriculture is tackling the problem of finding out the best leaf-yielding varieties of castor, and also castor leaves that give the best nutrition to the eri silkworms, so that the ryots taking up ericulture may grow the best variety of castor from the point of view of seed as well as leaf.

8. *Disposal of Reeled Silk.*—The price of silk varies from 150 to 180 rupees per maund of 1,000 tolas. The prices fluctuate according to the quantity and price of China silk imported into the market. The real menace to the silk industry of the Presidency comes, not so much from the competition of artificial silk, but from the large imports of cheap-quality Chinese silks into the Indian market.

The ways in which the Government may help to promote the industry are by:

(1) Establishing aided grainages.
(2) Starting of co-operative societies for the purchase of microscopes and purchase and sale of seed cocoons.
(3) Teaching microscopic work to intelligent rearers and helping them to purchase their own microscopes with the aid of Government loans.
(4) Levying a higher duty on cheap Chinese and Japanese raw silks in order to stabilise the price of Indian raw silk.
(5) Improving the silk-reeling industry by the introduction of improved machinery and finding a sale for improved raw silk at remunerative prices.
(6 Aiding the new silk filature and silk-throwing mill by the provision of loans under the State Aid to Industries Act.
(7) Supplying mulberry cuttings, good castor seeds, mulberry and eri silkworm seed free to the silkworm rearers.

BOMBAY

1. *Raw Silk.*—In the Bombay Presidency there are no silkworm farms for the production of silk cocoons. In the year 1923 the Bombay Government, in order to encourage sericulture, gave a Mr. Deshpande a concession on 40 acres of forest land near Sangamner (Ahmednagar) to carry out experiments on the culture of silkworms; after a period of seven years the experiment did not prove a commercial proposition, and Government then withdrew the concession.

2. *Weaving.*—There are two registered silk mill companies in the Bombay Presidency for the manufacture of silk goods with an authorised (issued and subscribed) capital of Rs. 10,00,000. During the year the above companies made an aggregate profit of Rs. 2,24,230. In addition to the two mills there are a large number of handloom and small power-loom factories scattered over the Presidency, which use silk for making the various sorts of cloth used by the people of the Presidency.

UNITED PROVINCES

1. The chief centre of the silk industry is Benares, where there are two silk mills, one of which worked during the year under review. Chinese and Japanese silk yarns

have sold at prices considerably below those of Bengal yarns, in consequence of which the latter were neglected.

2. The Swadeshi movement hit the silk trade very badly, and the business which had been built up in Madras and Gurat for Benares silk was reduced to very small proportions, owing to the agitation against the use of imported silk yarn. The Patel Silk Weaving Factory at Saharanpur had a very good year, and increased the number of looms from ten to fifteen. Other additions were also made to the plant and the dye house was enlarged.

3. In the earlier part of the year the Sindh Silk Weaving Works, Dehra Dun, did profitable business, but its business fell off considerably later owing to the trade depression. This factory obtained official assistance in the matter of improved methods of silk dyeing.

4. The hand-loom silk-weaving factories at Shahjahanpur suffered from a falling off in demand for their products and also suffered from competition with the Patal Silk Mills, Saharanpur.

PUNJAB

1. *Government Supervision.*—Silkworm rearing is being carried on in this Province under the guidance and supervision of a special staff of the Department of Agriculture. In the years 1928–32 the number of people, including school teachers, engaged in sericulture was as follows :

1928	1,195
1929	1,040
1930	1,238
1931	454
1932	147

2. *Cocoon Production.*—Silk-seed of the univoltine race of mulberry silkworms is reared in the Punjab and is obtained from France every year. After hibernating the seed at Dalhousie it is distributed among rearers early in February on cash payment at about Rs. 2–8 per oz. There is only one brood of these worms in a year. The cocoon crop is ready by the end of April, and in May a silk cocoon exhibition is held by the Department of Agriculture at Gurdaspur, where the majority of rearers bring their produce. An auction is also held at the same time and the crop is sold to the buyers, mostly from Amritsar. Some of the silkworm rearers sell their produce to silk dealers direct in their own villages. Formerly, the Department of Agriculture purchased the entire cocoon crop, either to reel it in the Government Reeling Factory at Sujanpur, or to sell it to buyers subsequently at better rates than offered

by them at the time of auction. For the last two years or so, however, the Department has not purchased any part of the crop, and reeling having been stopped, the entire annual production of cocoons is purchased by silk merchants from Amritsar who reel it by hand and sell the raw silk in the local market.

Reeling.—Machinery is not used for reeling silk in this Province. Cocoons of good quality yield 27 per cent. to 30 per cent. of raw silk by weight and about 12 per cent. of waste materials. Practically no cocoons are reeled by the rearers themselves. The following statement gives the quantity of cocoons raised under the supervision of the Agricultural Department, the amount of silk yarn produced and its approximate value during 1928–32 :

Year	Weight of cocoons raised	Quantity of silk yarn produced	Value of silk yarn
1928 . .	285 maunds	80 maunds	Rs 60,800
1929 . .	246 ,,	65 ,,	,, 48,400
1930 . .	200 ,,	50 ,,	,, 30,000
1931 . .	60 ,,	20 ,,	,, 19,400
1932 . .	50 ,,	12 ,,	,, 5,280

3. *Weaving.*—Raw silk is used by weavers for *daryai*, *gota* and other fine cloth, while the waste products, consisting of *gudder*, etc., are used in the preparation of a coarse kind of silk cloth. The price of raw silk has dropped down from Rs. 19 per seer in 1928 to Rs. 11 per seer in 1932 in silk markets in the Province. Yellow silk, as a rule, fetches a higher price than the silk yarn produced from white cocoons.

BIHAR AND ORISSA

1. *Mulberry Silk.*—Bihar and Orissa is richer in sericultural possibilities than any other Province in India, for it is not confined to one species of silkworm. The most important silkworms in the world, viz. the mulberry, tasar and eri worms, are found to thrive in this Province under conditions favourable to each species.

It is reported that Bihar once produced mulberry silk as well as " tasar," which now forms an important textile fibre of this Province. In the course of the last 100 years mulberry cultivation completely disappeared except in a couple of villages.

Based on the recommendations of the late Professor Maxwell Lefroy, the Department of Industries in Bihar and Orissa conducted experiments in sericulture in the district of

Ranchi for over eight years with a view to collecting reliable data as regards the most suitable methods of planting mulberry, seasons for pruning the plants and rearing of worms, irrigation of the plantation, manures required and the particular species of silkworm suitable for conditions existing in Chota Nagpur. It was demonstrated beyond doubt that the Bengal bush mulberry can grow on the Chota Nagpur plateau without irrigation and that the temperature and humidity of the atmosphere are favourable for rearing three to five broods of silkworms. If the plantation is irrigated, five crops can be raised in a year in the place of only three from unirrigated ones.

2. *Tasar Silk.*—Bihar and Orissa is the home of tasar worm which feeds on the leaves of "Ber," "Asan" and "Arjan" and a few other trees growing in the jungles of Chota Nagpur and Orissa. Most of the silk is reeled and woven locally by hand-weavers with their primitive appliances into indigenous patterns of cloth. According to the Census Report of 1921, 2,826 hand-looms are reported to be employed in tasar weaving and 2,717 in cotton and silk mixed goods. Tasar produced in this Province is diminishing largely as a result of economic causes. The jungle tribes who used to rear and collect cocoons are giving up this occupation as unprofitable, and the silk weavers have begun to weave waste spun-silk in preference to tasar.

Tasar worm being a wild insect, it is difficult to control its breeding and rearing. Again, experiments in hybridisation or selection of the finest species of worm have not as yet been undertaken, in the absence of qualified and experienced staff. Some improvement has, however, been effected in the manufacturing operations such as reeling, bleaching and dyeing at the Silk Institute, Bhagalpur. With a view to profitably utilising tasar waste, experiments in spinning the same on power machinery are being conducted at the Central Jail Factory at Bhagalpur.

3. *Eri Silk.*—The Department of Industries in Bihar and Orissa started demonstration of ericulture in rural areas after conducting some experiments in this branch of sericulture at the Silk Institute, Bhagalpur. This Institute now supplies to the prospective rearers of this Province disease-free seed eggs, free of cost, and offers to buy their cocoons and spun thread at market rates. Many people have now started eri-rearing, particularly in Orissa, and ericulture is being taught in over 400 primary schools in that area, as a subject for nature study and manual training. The Silk Institute designs and manufactures new patterns

in eri silk and finds new uses for the same, both in India and European countries. Some excellent designs in scarves, bedspreads, dress pieces, are being manufactured, and the unique wearing qualities of these home-spun and handwoven fabrics, as compared with those of ordinary mulberry and tasar silks, are being advertised. Eri silk fibre is finer than that of tasar or muga and has greater elasticity. Being white in colour, it can be dyed in light shades of colour. Again, on account of the absence of the bright lustre characteristic of other silks, its durability and quality of absorbing moisture like cotton, this silk is admirably suited for sportswear and underclothing.

With a view to testing the commercial value of eri silk in European countries three consignments of cocoons weighing about 1,000 lb. each were despatched to spinners in England (including one sent through the Director of Imperial Institute, London). The reports received, however, were not very encouraging, as the spinners stated that the eri yarn was not as strong as mulberry waste spun-silk, and the eri cocoons could only sell, on the English market, at prices not more than 2*s*. a lb.

4. *Bhagalpur Silk Institute.*—The Silk Institute started at Bhagalpur is the direct outcome of the recommendations made in the report of 1916 on " The Silk Industry in India " by Professor Maxwell Lefroy, and has for its object the development of the different branches of silk industry in all such operations as cultivation of food plants, rearing of the silkworms, reeling, spinning and throwing, dyeing, weaving, printing, finishing, etc. Besides training every year a few local artisans and about fifteen educated young men in sericulture and silk manufacture, experiments are being conducted with a view to evolving improved processes and labour-saving appliances. The Institute also designs and manufactures silk goods of artistic designs, both for local and foreign markets. The Institute offers technical advice and supplies local artisans with labour-saving appliances, fast dyes, new designs and seed eggs for rearing.

CENTRAL PROVINCES AND BERAR

1. The silk industry in this Province is on a very small scale and is gradually declining on account of the severe heat.

2. *Tasar Silk.*—Only tasar (locally known as *kosa*) silk is raised, principally in the districts of Bilaspur, Raipur and Drug and the States of Raigarh, Sarangarh and Sakti. A small quantity of kosa (tasar) silk is also produced in the

districts of Chanda, Bhandara Balaghat and Chhindwara (Seoni Sub-Division).

The quality of tasar silk grown in the Central Provinces is inferior and it is not used by the weavers for warp purposes. They use tasar cocoons imported from Chaibasa and from the Mayurbhanj State for warp. The quantity of silk imported into this Province during the year 1930–31 was 4,284 maunds. The industry supported about 3,962 persons during the same year.

3. *Weaving.*—There are nearly 500 tasar weavers in the Bilaspur district alone. They weave turban cloths, suitings, shirtings and coatings. Dhoties and sarees are also woven by about 50 families.

The only important place for tasar rearing and weaving is Champa in the Bilaspur district where about 100 families, with one loom each, produce cloth valued at Rs. 4,500 monthly.

The cloth produced in this Province is sold locally. Tasar cocoons are reeled for the personal use of the local weavers but not for sale. This work is mainly done by the womenfolk. About 75 tasar weavers of Champa are using fly-shuttle looms and they can use nearly 30 per cent. more tasar yarn than those working on the old pit-looms.

4. *Mulberry Silk* is not grown in this Province but is imported from Bengal. In the Nagpur and Nimar districts reeled mulberry silk is used for sarees and for borders of dhoties and sarees. Approximately reeled mulberry worth about Rs. 5,000 is used in this Province monthly.

ASSAM

1. *Experimental Station.*—From the experiments carried out at the farms at Shillong and Titabar, it appears that the yield of silk of cocoons produced in the hills is greater than that of lowland cocoons. Although hill seed decreases in weight when reared in the plains, even then the improved seed obtained from the hill station retains its established superiority over the local varieties for several generations, and its deterioration is checked by the elimination of diseased seed by means of microscopic examination. The two stations work in conjunction with one another and both are necessary: one to raise healthy and disease-resistant seed and the other to demonstrate rearing in improved methods with good seed in surroundings to which people actively engaged in this occupation are accustomed. The villagers have yet much to learn in the use of scientific methods.

Satisfactory reports have been made on the work at the hill station. Although the plantation of food plants and rearing operations have been done on a small scale, the result so far achieved has been quite satisfactory and encouraging. It is a pity that the station has been threatened with acquisition by the military authorities for extension of their rifle ranges, and the Department will probably have to vacate it within a few months. In the opinion of experts a hill station is necessary for the production of healthy and disease-resistant seeds. The question of starting another station in the hills is still under the consideration of the local Government.

2. *Sericultural Demonstrations.*—There are six demonstrators engaged in propaganda work in selected centres in the districts of Lakhimpur, Sibsagar, Darrang, Nowgong, Cachar and Sylhet. The number of demonstrators is quite insufficient for the needs of the Department for such an important industry as sericulture in Assam. It is considered that with proper State help and co-operation of the people, much can be done to improve the industry and thereby the resources of the cultivators. As it is almost out of the question to strengthen the staff during the present financial stringency, it has been decided that, instead of expanding the activities, a policy of concentration at certain selected areas should be adopted with the assistance of the Co-operative department in order to secure improved results.

In their work the object of the demonstrators has been to introduce sericulture amongst newly interested persons and to help existing rearers in improved methods in as many villages as possible. The idea might have been good had it been possible to strengthen the staff to cope with the increased work, which is inevitable under this system. Owing to the decision to concentrate work in certain suitable centres it will only be feasible to cater for a very limited number of villages with the slender resources available.

An improved eri spinning machine and a Bengal home reel for reeling mulberry silk cocoons were at work in the districts of Sibsagar, Darrang and Nowgong.

The village rearers obtained fair crops of muga, eri and pat during the year.

3. *Artificial Silk* (*Rayon*).—There has been much discussion as to whether artificial silk will oust the natural silk. It appears, however, from figures given by European experts that in spite of the great activity of the artificial silk industry, the production of real silk has in fact increased in recent years and in their opinion there is little

danger of its progress being checked. Much will depend on the ability to keep down or lower the costs of silkworm rearing and reeling, the two factors on which the cost of production mainly depends. In a province like Assam, with its cheap labour and cultivators, already familiar with this industry and with much spare time, the prospects should be quite encouraging. What is really required is to give them facilities to increase their out-turn with better seed and improved methods.

BURMA

1. *The Industry.*—The silk industry of Burma is practically limited to the weaving of silk cloth, on hand-looms, from raw silk imported from other countries. Very little raw silk is produced in the Province. Government is trying to develop the industry and the sericulture branch is under the Agricultural Department. A note by the Entomologist of the Agricultural Department, who is in charge of sericulture, is quoted below. The information which follows, therefore, refers to manufacture of silk cloth, on hand-looms, from imported raw silk.

2. *Origin of Raw Material.*—The main source of supply of raw silk to Burma is from China. The bulk of this, which is produced in the interior of China, is imported on caravans by transfrontier routes, whereas silk produced nearer to the sea coast is imported by sea. The former is mostly twisted and is of good quality, while the latter is untwisted and is of coarse quality. It is imported in large skeins and is sorted and converted into smaller skeins locally and is sometimes twisted. Comparatively little silk is imported from India. Chinese silk is more suited for the kind of material woven in Burma and is cheaper ; this explains why nearly all the silk imported into Burma is from China.

3. *Imports of Raw Silk.*—The present condition of the silk industry can be judged from the imports of raw silk into the province, as it is all used by hand-loom weavers. The latest figures of imports available are for the year 1930–31 and the comparison of these with figures of past few years will give an idea of how the industry stands at present. Table I, given below, shows the imports into the Province of raw silk by land and sea and the total of these for five years ended March 1931. It also affords an idea of the proportion of Burma's land-borne trade in raw silk with China, as compared with sea-borne trade, because all the silk imported by land and most of the silk imported by sea is from China.

TABLE I

Imports of Raw Silk into the Province of Burma During Five Years Ended March 1931

Year.	By Land. *lb*	By Sea. *lb.*	Total. *lb.*
1926–27	402,212	112,366	514,578
1927–28	355,638	102,658	458,296
1928–29	300,342	39,168	339,510
1929–30	394,806	28,131	422,937
1930–31	350,948	11,643	362,591

4. *Imports of Manufactured Silk.*—The figures in Table I above will show that there has been a decrease in the silk industry of the Province during the period shown. This may be attributed to two chief causes. The first is the general depression in trade which has reduced the buying power of people, especially of the agriculturists, who form the majority of the people of the Province. Silk is more or less a luxury, and when people find it difficult to buy bare necessities of life it can well be understood that they cannot indulge in articles of luxury like silk. This can further be seen from the fact that even the imports of manufactured silk, as shown in Table II below, have fallen a great deal in spite of their greatly reduced cost.

TABLE II

Net Imports of Manufactured Silk into the Province of Burma During Five Years Ended March 1931

Year	Quantity. *Yards.*	Cost. *Rs.*
1927–27	3,684,218	5,065,002
1927–28	3,809,899	4,915,039
1928–29	3,681,930	3,739,251
1929–30	3,298,466	2,797,147
1930–31	1,769,937	1,254,175

5. *Artificial Silk (Rayon).*—Another reason for decrease in the silk industry is the increasing use of artificial silk by hand-loom weavers in recent years, as shown in Table III below. Artificial silk possesses lustre as good as or better than real silk and is far cheaper. It cannot, however, compare with the latter in durability. But a buyer, especially at the present hard times, cares more for cheapness than quality, and to reduce the cost of manufactured cloth and to make it more saleable in competition with imported cloth, the hand-loom weaver who was formerly doing silk weaving has had to use artificial silk more and more. Introduction of artificial silk in the market is, however, recent, and it is likely that in time to come people will realise the advantages and disadvantages of the two commodities, i.e. silk and artificial silk, and as conditions

improve the silk industry is sure to revive. The two commodities have separate spheres of use, and artificial silk will, if at all, be a competitor with cotton rather than with silk.

TABLE III

Imports of Artificial Silk Yarn into the Province of Burma During Five Years Ended March 1931

Year.	Quantity. *lb*	Cost. *Rs.*
1926–27 . .	26,087	43,341
1927–28 . .	87,072	159,859
1928–29 . .	181,096	474,569
1929–30 . .	335,425	425,729
1930–31 . .	311,082	374,629

6. *Production of Silk Cloth.*—The magnitude of the silk industry, even in its present condition, can be seen from the following figures of approximate production of silk cloth and from comparison of these with the imports of manufactured silk or with the total consumption of silk cloth in the Province. Calculating from the average import of raw silk for two years 1929–30 and 1930–31, the annual approximate production of silk cloth in the Province amounts to 1,472,000 yards of 33,14,000 rupees in value. Against this the average annual import of manufactured silk for the two years 1929–30 and 1930–31 was 2,534,000 yards of 20,25,000 rupees in value. The production of silk manufactured in Burma thus amounts to 36 per cent. in quantity and 62 per cent. in value of the total consumption of silk in the Province. The difference in the relative proportions in quantity and value is because about 80 per cent. in quantity and 60 per cent. in value of the manufactured silk imported into Burma is from Japan and consists of narrow, thin and cheap-quality fabrics suitable for gaungbaungs and pawas. This increases the proportion of import in quantity, but the value of the cloth being low the proportion in value is reduced. Weavers of Burma at present do not weave this kind of thin silk. On the other hand, the above calculation of production of silk cloth by hand-loom weavers in Burma has reference to wide silk of average thickness as is generally used for lungyis and pasoes. Further, the production of cloth from raw silk produced in Burma is not included in the above calculation. If these facts are taken into consideration and the import of Japanese thin silk, which is not woven by Burmese weavers, is omitted, it will be seen that the bulk of silk cloth used in Burma is of Burmese manufacture.

7. *Note by Entomologist, Agricultural Department.*—Development of sericulture and production of raw silk are in the hands of the Entomologist in the Agricultural Department. There are arrangements for (*a*) research and experiment for the improvement of races of worms and of mulberry, and (*b*) development and expansion of rearing among cultivators. For the former purpose the Department maintains sericultural stations at Maymyo and Mandalay and development is being carried out with two outside nursery stations, one in Paukkoung Township in Prome District and the other in Leiktho Township in Toungoo District. The other smaller rearing localities which have not developed so much, viz. some villages in Taungdwingyi Township, in Amherst District and in the Northern and Southern Shan States, are supplied with eggs from Maymyo and Mandalay.

Up till now efforts have been directed towards increasing production. The rearers still reel their own cocoons and sell the resultant thread in their local markets; the thread is used in weaving lungyis, bags, etc. When production increases further, the proposed plan of the Department is to develop reeling as a separate industry by purchasing cocoons from rearers. Thus a standardised thread can be produced and it is further proposed to place the threads in the market in a twisted (thrown) condition. Work is being developed in this direction. At present the total production of raw silk in the Province is only about one-tenth of the demand, which is met principally by importations from China and Siam.

Mysore State

1. *Area Under Mulberry.*—The abnormally low prices and fluctuations in the Silk Market during the last three years were unfavourable for increasing the area under mulberry. During 1930–31 the total area was 42,881 acres.

2. *Seed Supply by Government Grainages.*—There is a marked increase as regards preparation and distribution of disease-free layings by Government grainages year by year. The total preparation and distribution during 1930–31 was 12,90,804 and 12,17,649 disease-free layings, respectively, as against 10,40,540 and 9,79,000 disease-free layings during 1929–30.

3. The preparation and supply of cross-breed layings (Mysore × Japanese or Chinese) is being increased every year. The hybrid layings are popular with the sericulturists as they yield larger cocoons in the shorter period than the Mysore worms. Arrangements have been made

to get fresh stocks of seeds every year from Japan to facilitate in preparing good F1 layings.

4. *Aided Grainages.*—Efforts have been made to increase the number of aided grainages in the State and to standardise the work. Educated young men are coming forward for training in various sericultural farms with the idea of starting aided grainages after completing their training. There are thirteen aided grainages working in various parts of the State. The total preparation and distribution of layings by the aided grainages during 1930–31 was 12,78,575 and 12,41,456 disease-free layings as against 7,10,546 prepared and 6,89,207 supplied during 1929–30.

5. *Sericultural Co-operation.*—There are twenty-one Sericultural Co-operative Societies and the activities of the Societies are confined to preparing disease-free layings, rearing chawki, adopting preventive measures to combat diseases of silkworms, training members in improved rearing technique and marketing of cocoons, etc. The Societies prepared and supplied 1,23,200 disease-free layings during 1930–31.

6. *Seed Campaign.*—The work in the seed areas has been systematised. There are 460 approved seed rearers and they are supplied with disease-free layings free of cost by the Government Farms. The total number of seed cocoons produced by them during 1930–31 was 350 lakhs as against 140 lakhs during 1929–30. The seed cocoons produced by them are purchased both by Government Farms and private sericulturists, and have given entire satisfaction.

7. *Sericultural Loans.*—Financial help is rendered to sericulturists of the State to encourage the silk industry both in the form of sericultural loans and for the purpose of purchasing domestic basin units for reeling, on the hire-purchase system. A total sum of Rs. 12,715–12–0 was distributed as loans to the sericulturists during 1930–31.

8. *Propaganda.*—Departmental staff in various sericultural centres are engaged in intensive propaganda work to improve the silk industry. The sericulturists are being induced to grow tree mulberry, to adopt improved rearing methods and to purchase disease-free layings, etc. Attention is given to popularising domestic basins.

9. *Experimental Work.*—Special attention is being paid to conducting experimental work on silkworms and mulberry. Attention is also given to improving the local race of silkworms. Attempts are being made to find out the best foreign race suited in preparing F1 layings during different months of the year. Genetic work on silkworms has also been commenced.

10. *Mulberry.*—As the Japanese mulberries fail to root if cuttings are planted, various other methods, such as grafting, budding and marcotting, etc., have been tried to multiply in order to make a comparative study of various mulberries for rearing silkworms. Seedlings of Japanese, Korean and other mulberries have been raised for grafting purposes.

Experiments to study the effect of various artificial and natural manures on mulberry as regards the quantity and quality of leaves produced are being conducted. Steps have been taken to isolate the local male mulberry and to make a comparative study with local female mulberry regarding yield of leaves, etc. Experiments are in progress to improve the cultural operations in mulberry gardens with the object of increasing the yield of leaves.

Spraying experiments with potassium sulphide to eradicate mildew disease in mulberry are also in hand. Comparative studies regarding the expenditure and receipt from one unit area of bush and tree mulberry are in progress.

In addition to the above, cold-storage experiments are being carried out to ascertain: (1) how many days the hatching of the eggs of multivoltine races may be conveniently delayed without danger to the health of the worms, (2) the number of days the emergence of moths may be delayed to facilitate preparing the F1 layings.

11. *Filature.*—Eighteen trench basins have been installed in the new Filature Buildings. Most of the silk produced up till now was to the orders of the merchants of various places. In future the total quantity of raw silk produced will be supplied to the New Weaving Factory, Mysore. The total production of raw silk during 1930–31 was 4,841 lb.

The major portion of the cocoons consumed in the filature are Mysore cocoons and steps have been taken to increase the output of cross-breed (hybrid) cocoons in the State with a view to utilising them for reeling purposes.

12. *Domestic Basins.*—Efforts are made to popularise the domestic basin units for reeling purposes throughout the State. During 1930–31 five sets of five-basin units, two sets of double-basin units and three sets of single-basin units were supplied. On the whole there are twenty-five five-basin units, three double-basin units and five single-basin units working in the State. Reeling classes to train workers in several private domestic basin installations are also conducted at Government cost. The work in the domestic basin units has been slack during the current year due to the fall in silk prices.

13. *Silk-twisting Classes.*—Grants are sanctioned to

run silk-twisting classes to improve the quality of country charka silk and to provide subsidiary occupation for " Purdah " ladies. In addition to three schools started during 1929–30, four more new schools were started during the year 1930–31, and more than 250 people were trained. The demand for silk-twisting schools is on the increase.

14. *Demonstrations and Exhibitions.*—Reeling demonstrations to popularise domestic basins, rearing demonstrations to teach improved method of rearing, and grainage demonstrations to induce the sericulturists to take only disease-free layings, are going on in important sericultural centres. Sericultural exhibits from Government Farms and sericulturists, high-grade fabrics produced in Switzerland with Mysore silk, are exhibited during Dasara Exhibitions every year. Reeling and cocoon-drying demonstrations are also demonstrated.

15. *The Weaving Factory.*—A Demonstration Weaving Plant for producing high-grade silk fabrics from Mysore silk has been installed in Mysore along with an up-to-date silk dyeing and finishing plant. Work in the Weaving Section was started early in December 1931. The work in the Dyeing Section will commence early in June 1932. It is expected that the fabrics produced in the factory will command a good market in India and will give an impetus to the silk industry in the State.

NOTES

The Indian Silk Industry.—The Report of the Indian Tariff Board regarding the Grant of Protection to the Sericultural Industry in India which has been expected with much interest in this country has recently been published. The enquiry into this subject was referred to the Tariff Board under the following Resolution of the Government of India, dated December 3, 1932 :

" It has been represented to the Government of India that notwithstanding the existing high revenue duty on imported raw silk the recent increase in imports of that commodity from foreign countries constitutes a grave menace to the existence of the indigenous sericultural industry. It has therefore been decided that the claims of the industry to protection should be the subject of an enquiry by the Tariff Board. The Board is requested to examine the following questions and to make recommendations :

> "(*a*) whether, having regard to the nature and extent of the competition of raw silk from foreign countries, the claim of the sericultural industry to protection has been established ; and
>
> "(*b*) if the claim is found to be established, in what form protection should be given and to what extent."

As is customary in the reports of the Indian Tariff Board the present document, which comprises 200 pages, contains a full statement of information regarding the industry collected by the Board in the course of their enquiries, and taken into consideration by the Board in framing their recommendations. The report thus presents a most valuable account of the Indian silk industry and brings up to date in concise form much information contained in the late Professor Maxwell Lefroy's exhaustive report on the industry published in 1916.

Four varieties of commercial silkworm are raised in India, viz. the mulberry worm (*Bombyx mori*), the tasar (*Antheræa Paphia*), the muga (*Antheræa assama*) and the eri (*Attacus ricini*). Of these the mulberry worm is by far the most important and the Board's enquiry was confined to mulberry silk. The three principal areas of production in India are the Assam-Bengal plain, Kashmir, and Mysore with the adjacent Kollegal taluk. The efforts made by the East India Company to encourage silk-raising in Bengal led to the development of an important export trade in raw silk which was well known in the European market, but on the abandonment of the industry by the Company in 1836, following the loss of their silk monopoly in 1813, silk was neglected by the Government and exports fell. The industry declined as a result of disease of the worms and the competition of other crops and occupations ; and, in later years, competent observers have attributed much to the conservatism which characterises the industry as a whole. However, the modern industry in Kashmir was started in 1905 and was able to take full advantage of the boom created during the War, which was also responsible for the revival of the Mysore silk industry. The boom lasted in India until 1923, since when silk prices have steadily fallen. The silk exports from India had fallen from 235,000 kilos. in 1909 to 34,000 kilos. in 1914 and, with the passing of the boom conditions, the exports of raw silk and waste have rapidly diminished until at present they are negligible. The industry has come to depend upon the home market; at the present day the hand-loom weaver is the chief consumer of Indian raw silk.

It is the threat even to this market which was the *raison d'être* of the Tariff Board's enquiry. Unable to find an outlet in the United States, Chinese silk, assisted by the abolition of export duty and by bounties, has entered the Indian market in increasing amounts at uneconomic prices; and since December 1931, when Japan left the gold standard, the Indian industry has been attacked at the other end by an enormous development of imports of Japanese silk and rayon (artificial silk) goods. There is good reason to believe, however, that sericulture, as such, in India is capable of improvement and great expansion. The organisation of the industry on modern lines is essential to effect this, and the Tariff Board quotes and supports the view of Mr. Norton Breton, Chairman of the Imperial Institute Advisory Committee on Silk Production, that Government control and supervision of such action is necessary. Work in this direction is in progress by Provincial and State Governments, but these useful efforts are regarded as needing co-ordination by a central authority.

In considering the case for protection of the industry, the Board carefully examined the contributory causes of the rapid decline in recent years and the increasing commercial menaces with which the industry is confronted. The chief dangers which have threatened the industry are the loss of the export market, the shrinkage in the world demand for silk and silk waste, a tendency in India to replace local raw silk by cheaper substitutes, the low price of Chinese silks, and the dumping of silk manufactures in India. The causes which have made this state of affairs possible are stated to be the fall in the Chinese and Japanese exchanges, the American crisis of 1929 and the consequent disorganisation of the world's financial and economic arrangements, decline of purchasing power, and the Chinese bounties on raw silk exports. The Board recognises that the raw silk industry of India occupies an important position in the economic structure of the country and that apart from competition from depreciated exchanges and bounties is nearly able to hold its own. The great need of the industry is reorganisation, which can only be successful if undertaken with Government assistance. Protection is necessary in the interests of the agricultural as well as the weaving industry. The Board therefore recommends protection of the industry for five years while it is reorganised, and a further enquiry at the end of that period to ascertain what use the industry has made of its opportunity and whether it needs further protection.

The summary of recommendations of the Board is as follows:

"The first stage of investigation into the cost of production deals with the cost of cocoon production, the most important item of which is the cost of cultivating mulberry. There is considerable variation in the costs stated to us; but we have come to the conclusion that the present cost is about 4 annas a pound in Bengal and 4½ annas elsewhere. We have decided to base our recommendation on a price for cocoons of 5 annas a pound. There are similar variations in the costs of reeling by charkha. We estimate the works cost of producing a pound of raw silk by charkha at Rs. 5–12–4, Rs. 5–1–4 and Rs. 4–10–8 for first-, second- and third-quality silk. Adding overheads, we arrive at fair selling prices of Rs. 6–2–6, Rs. 5–4–3 and Rs. 4–13–5. There is variation again in works expenditure between one filature and another. We estimate the works cost of producing a pound of silk in a filature of economical size working to full capacity at Rs. 6–4–0 and the fair selling price at Rs. 6–10–9. To estimate the measure of protection needed we compare (1) the prices of imported filature and re-reeled silk with the price of first-quality charkha silk and (2) the prices of imported native-reeled silks and filature dupions with those of second- and third-quality charkha silks. The average price of imported filature and re-reeled silks is Rs. 3–12–0 and the average price of native-reeled and filature dupion is Rs. 2–10–7. The difference between Rs. 3–12–0 and the price of first-quality charkha silk (Rs. 6–2–6) is Rs. 2–6–6; and the difference between Rs. 2–10–7 and the average of the prices of second- and third-quality charkha silk (Rs. 5–0–10) is Rs. 2–6–3; we recommend a specific duty of Rs. 2–6–0 a pound. This will afford enough protection for filatures as well as for charkha silk. We also recommend that the alternative *ad valorem* rate of duty be raised to 50 per cent. We believe that this rate is adequate and not excessive. We recommend that it apply for a period of five years and that it be applied to all classes of raw silk; we also recommend that the 50 per cent. *ad valorem* duty be applied to cocoons. We suggest that emergency action be taken on our report under the provisions of the Safeguarding of Industries Act, 1933.

"We recommend that the *ad valorem* rate of duty on silk goods be raised to 83 per cent.; that the *ad valorem* rate of duty on silk mixtures be raised to 60 per cent.; that all silk yarns, including thrown silk and spun silk, be liable to the duty which we recommend for raw silk; that thrown silk and spun silk be entered separately in the trade returns; and that a specific duty of Re. 1 a pound be levied on artificial silk yarn. We do not propose to touch the specific duties on artificial silk goods and mixtures, but we recommend that their *ad valorem* rates of duty be raised to the same level as those which we have proposed for silk goods and mixtures. Research should be carried out by Provincial and State Governments and their results co-ordinated by a sericultural committee of the Council of Agricultural Research, which should arrange for such financial assistance as may be required and suggest legislative action when necessary. This committee should explore the possibility of improving facilities for sericultural education. Improvements in marketing should be undertaken, and the establishment of conditioning houses should be taken up. Generous financial assistance should be provided. The collection of statistics should be improved. The Government should watch the course of prices and be ready to apply the provisions of the Safeguarding of Industries Act, if need arises. Steps should be taken to include raw silk in the list of Imperial preferences."

Cultivation of *Aleurites Fordii* in the Southern Shan States, Burma.—In an article dealing with the experimental cultivation of Tung trees which was published in this BULLETIN (1932, **30**, 24–35) reference was made to the trials that were being conducted in the Southern Shan States, Burma, to ascertain whether Tung trees could be successfully grown there, and if the trees would yield Tung oil of commercial quality. More recently a full account of these experiments, carried out by the Forest Department, has been given in the *Indian Forester* (1933, **59**, 560–571), from which the following information is obtained.

Aleurites Fordii is not indigenous to the Southern Shan States, although *A. montana*, from which Chinese wood oil is also obtained, has been found in the Mong Yawng Circle of the Kengtung State (see this BULLETIN, 1924, **22**, 217). The earliest attempt on record to grow *A. Fordii* in the Southern Shan States was initiated by the Imperial Institute, who in 1923 sent out a few pounds of seed of Chinese origin. It has, however, not been possible to obtain any information as to the progress of these experiments.

In 1928 further trials were started at the instance of the Inspector-General of Forests in the neighbourhood of Taunggyi, at an altitude of about 5,000 ft. In this locality the average rainfall is about 60 in. per annum, practically the whole of which falls between May and October. The shade temperature varies from a day maximum of about 90° in the height of the hot weather to a night minimum of about 32° in the winter. The underlying soil is limestone and the surface soil a fairly stiff brown loam containing little or no lime.

Three consignments of Tung fruits were received in 1928, two of which were obtained from the Silviculturist, Dehra Dun, and the third from Kew. The smaller of the two parcels from Dehra Dun yielded 30 seeds, which were sown in June ; 29 of these seeds germinated 8 days later. The nursery was watered daily during the dry weather, and at the end of February 1929 the seedlings, then 8 months old, were 8 in. high. Of the other parcel from India only 40 per cent. were sound.

The consignment received from Kew yielded 830 seeds, of which 650 were sown in June at a spacing of 20 ft. by 20 ft. at an elevation of about 3,500 ft. in the Hopong Valley, about 7 miles from Taunggyi ; the remaining seeds were planted in the same month in the Taunggyi Fuel Reserve about 3 miles from Taunggyi.

The area selected for the trials in the Hopong Valley was situated in typical "*ya*" (shifting cultivation) country on which sugar cane is grown one year, and wheat the next, after which the land lies fallow for three years. Of the 650 seeds sown only about 30 per cent. germinated ; 72 seedlings were alive at the end of February 1929, and were from 6 to 7 in. high ; but by the end of the following November they had all died.

The seeds sown in the Taunggyi Fuel Reserve were sown in a potato "*ya*" at 4,200 ft. altitude. Germination in this case was very slow and erratic, and was about 50 per cent. Most of the plants withered away during an exceptionally long break in the rains, and by the end of February 1929 only 19 survived and were then 6 in. high.

Further data on the cultivation of Tung trees in the Southern Shan States were obtained from plantations established in the Taunggyi Fuel Reserve, South Block, in 1929 and onwards. Seed for this purpose was received from Kew and Nanking. Germination in the case of one consignment was *nil*, while in other experiments it was below 50 per cent. and the period required varied from 30 to 45 days. The seeds were sown in the nursery beds about a foot apart in rows which were also a foot apart.

No manure was applied and beyond the usual weeding no special treatment was given to the beds. Sowings made during May and June showed up to 50 per cent. germination, while those in mid-August 1929 gave no results. Experimental sowings in March are to be carried out when sufficient seed is available.

As regards the preparation of the land prior to transplanting the seedlings, two methods have been tried in the Southern Shan States. In certain States, the waste land is cleared and holes dug 18 in. deep and a foot square at a spacing of 20 ft. by 20 ft. square planting. Direct sowing as well as transplanting has been tried in these districts. Near Taunggyi the preparation of the soil is more intense and the seedlings have been grown on potato "*yas*." In this form of cultivation, the undergrowth is cut in September, and the land is ploughed and harrowed, while the earth is still soft. In December the trees are cut, parts suitable for firewood disposed of, and the remaining branchwood, twigs, roots, etc., collected in heaps at intervals on the cleared ground. These heaps are allowed to dry and are burned in March. The soil is then raised into mounds, inside which farmyard manure is placed and burned. In April these heaps are levelled, lines roughly marked on the ground, potatoes sown in these lines, and the earth heaped up over them to form parallel raised lines. In the case of Tung, the area is staked 6 ft. by 6 ft. soon after the ground has been levelled if this tree is to be cultivated with other species or 24 ft. by 24 ft. if a pure stand is required.

Direct sowing of Tung seed cannot be relied upon, as the results depend to a great extent upon the viability of the seeds sown. It is therefore preferable to plant up areas with seedlings raised in nurseries. Experiments in transplanting seedlings varying in age from one month to one year or more have been made with success. Transplanting was first tried with balls of earth, but later this method was abandoned. In most cases the seedlings have been transplanted whole, but in a few cases the plants have been cut back to a height of about 18 in. and in one or two cases they were cut down to 2–3 in., the roots also being pruned below the carrot-shaped portion. All these methods have proved successful. Transplanting has been tried at different times of year ; one-month-old seedlings have been moved at the end of July during rainy weather ; three-months-old plants towards the end of October and year-old transplants during the rains. The results obtained have been better than those from direct sowing, the percentage of success being over 50.

Manuring experiments were carried out in 1930, but were discontinued, as the results showed little difference between the manured and untreated plots.

When Tung is being grown in potato "*yas*," the cultivation of potatoes is carried out for two or three years in succession. In the first year no Tung seedlings are planted, these being put down in the second year. Paddy and wheat were cultivated alongside Tung in this Reserve, and from the results obtained it is concluded that it is preferable to grow wheat rather than paddy as the former is cultivated during the resting period of Tung while the paddy season coincides with its growing period. The cultivation of cover crops has not yet been tried.

Statistics relating to the growth of Tung trees in the Southern Shan States are available from 1929. At the end of each of the first four years the average height was respectively, 1 ft., 1 ft. 6 in., 4 ft. 5 in. and 5 ft. 5 in. The area now under Tung is 32 acres, of which 26 acres were planted in 1929 and the remaining 6 acres in 1931.

Some of the 1929 plantations flowered for the first time in March 1932, and again early in March 1933. Flowers appear before or at the same time as the new leaves in March and remain on the trees till about mid-April, when most of the petals fall and fruits form. They are of the usual type, one in each cluster being female, and the remainder male. The fruits ripen in September. The plants in the 1929 plantations did not all flower, and so far 24 acres, containing 1,480 trees, have yielded only 108 fruits. These fruits have been examined at the Forest Research Institute, Dehra Dun, and were found to contain 46·5 per cent. of oil in the kernels. This oil content is below the average (56 per cent.) for Chinese kernels.

Potash and Bromine from the Dead Sea.—With reference to the statement on this subject recently given in this BULLETIN (1933, **31**, 382), the Imperial Institute is informed by Palestine Potash, Ltd., that they did not restrict their activities in 1932, that the production programme approved by the Board in 1929 has been successfully carried out, and that the output for 1933 was five years ahead of the production figures stipulated in the concession agreement with the Government.

RECENT RESEARCH ON EMPIRE PRODUCTS

A Record of Work conducted by Government Technical Departments Overseas

AGRICULTURE

BEVERAGES

Cocoa

Gold Coast.—The following report on investigations conducted during the period July to December 1933 has been supplied by the Director of Agriculture.

Sampling at Ports.—Statistics, relating to the defects and purity of cocoa shipped during the crop year 1932–33, have been analysed. The crop-year export period, October to September, includes about 95 per cent. of one crop-year production—a major and a following minor crop. From monthly mean purity figures alone it is impossible to separate major and minor crops, so that to get a valid conception of changes in purity over different seasons it is safest to take the annual export period October 1 to September 30.

Mean percentage purity figures for the last six crop years are as follows :

1927–28.	1928–29.	1929–30.	1930–31.	1931–32	1932–33.
88·5	88·4	87·7	89·1	89·1	88·4

The percentage purity is the per cent. by count of good beans.

Mean percentage purities and tonnage exported for each month during 1932–33 were :

		Tons	Purity.
1932	October	18,799	90·0
	November	24,694	93·0
	December	41,252	92·4
1933	January	32,577	90·9
	February	22,664	88·7
	March	19,168	88·3
	April	13,309	86·6
	May	15,812	84·7
	June.	16,899	82·3
	July	15,063	84·5
	August	20,847	84·7
	September. . . .	8,719	79·5

Shipments during the months of May, June, July and August are abnormally heavy and the low purity figure for the year may be partly ascribed to the prolonged storage of the major crop on the Coast.

Size of Beans.—The size of beans in the 1932–33 crop engaged much attention. The following table gives the number of beans per 14 cubic inches for cocoa exported each month ; the major and minor crops are shown separately :

		Major crop	Minor crop
1932	October	131·3	not available
	November	133·1	
	December	134·4	
1933	January	134·2	
	February	138·9	
	March	137·6	
	April	140·2	
	May	141·0	158·3
	June	138·0	152·0
	July	137·3	148·5
	August	138·7	141·2
	September	138·6	134·9

On the average there is a difference of ten beans per 14 cubic inches between major and minor crop, the former beans being the larger. On the other hand it is of interest to note that the best of the minor crop beans are larger than the smallest of the major crop. Since October 1, 1933, in addition to the above measure of volume, the number of beans per 4 oz. weight has been recorded at all ports. Comparison of 1932–33 and 1933–34 crops for the portion of the latter already shipped showed that beans in the 1933–34 crop are appreciably larger. This was expected, as climatic conditions during 1933 were more favourable for growth and pod development than in 1932.

Analysis of data, collected at the Accra port with the aim of finding indices of size and plumpness and various linear, volumetric and gravimetric measurements, has been carried out and published in a memorandum by the Division of Statistics and Surveys.

Cocoa Bean Moth.—The Entomologist has continued his investigations regarding possible means of controlling the cocoa moth, *Ephestia elutella.* Port inspection figures show that comparatively little damage resulted from the outbreak of the pest in local stores early in 1933. Breeding trials have shown that the larvæ æstivate during periods of low relative humidity and that this, together with the dying off of the parasite owing to food shortage, accounts for the sudden appearance of large numbers of moths after the harmattan. Experiments have been carried out with different types of distributors of calcium cyanamide, which has been proved to be an effective and economical insecticide for pests of stored cocoa, in an attempt to evolve a type which will be suited to local methods of storing cocoa.

Further studies have been made of the parasite *Micro-*

bracon hebetor. This insect lays eggs on the full-grown larvæ of the moth when they leave the beans to pupate. The larva is first stung and paralysed and eggs are deposited in groups of from one to twenty on its back. These hatch out in a day or two and the resultant larvæ feed on the moth larvæ from outside. Periods in the life-history average :

Incubation period	Larva stage	Pupal stage	Total.
2 days	5·8 days	8·5 days	16·3 days

The adults may mate and lay eggs on the day of hatching from the pupal stage and one female can lay as many as 250 eggs. Methods of breeding and using this parasite to control outbreaks of the moth are being studied.

Cocoa Bean Weevil.—The Entomologist has continued work on the cocoa weevil, *Aræcerus fasciculatus.* It has been definitely ascertained that beans having a moisture content of over 8 per cent. are preferred by the adult weevil for egg-laying. Also that immature stages of the larvæ can develop more quickly in imperfectly dried beans. The eggs of weevils are destroyed if exposed to a temperature of 52° C. for three hours or 55° C. for one hour. These temperatures may be reached in cocoa drying in bright sunlight.

Cocoa Producers' Co-operative Societies.—The position of these societies on January 1, 1934, is shown in the following table :

District	Number of societies	Number of members	Share capital subscribed. £	s.
Sefwi	26	431	215	18
Bekwai	36	657	465	13
Kumasi	43	836	483	13
Ofinso	37	747	451	6
Efiduase	45	1,035	674	17
Juaso	18	280	111	15
Koforidua	11	217	222	7
Kwahu	14	247	67	12
Akwapim	6	143	123	0
Krobo	39	1,338	1,078	17
Nsawam and Kibi	27	612	898	9
Trans-Volta	34	693	508	9
Oda and Kade	38	751	918	18
Cape Coast	16	324	124	16
Saltpond	5	92	21	16
Winneba	17	438	420	12
Totals 1/1/34	412	8,841	6,787	18
Totals 1/1/33	380	7,625	4,708	16

Indebtedness of Cocoa Farmers.—The indebtedness of cocoa farmers is becoming a very grave problem in the industry. The taking of advances against the crop several months before it is due to ripen and the mortgaging of farms are resulting in the production of cocoa of poor quality and the neglect of farms. Comprehensive investigations throughout the cocoa-producing area have revealed that about 40 per cent. of farmers habitually pledge part of their crop for cash advances and that advances are made at one half of the price of which the lender expects to be able to sell the cocoa. When larger sums are required farms are mortgaged and the lender takes the produce of the farms as interest on the sum lent. It is estimated that about 30 per cent. of farmers have mortgaged farms, but that only in a few cases have farmers mortgaged all their farms.

Manurial Trials on Cocoa.—Experiments with different types and mixtures of manures are still being carried out on Agricultural Stations and native-owned farms. Examination of the results to date show that though applications usually result in slightly increased yields such increases are in no case equal to the cost of the manure. Trials have shown that mulching gives slightly increased yields, but it is still doubtful if this is an economic operation.

Tea

Gold Coast.—According to the report of the Director of Agriculture for the period July to December 1933, a supply of tea seed was obtained from Ceylon and distributed to stations. Germination was high and plots have been planted out at Kumasi and Aburi. Growth to begin with was satisfactory, but since the onset of the dry season has been less so, mortality amongst young plants being high.

CEREALS

Rice

Sierra Leone.—Mr. C. Hargreaves, Entomologist to the Department of Agriculture, in his report for the period July–December 1933, refers to experiments on the control of the weevil, *Calandra oryzæ*, in rice. He states that fumigation of rice with carbon bisulphide used at the rate of 7½ lb. per 1,000 cubic feet, for 48 hours, killed all stages. Further work is to be done to arrive at the minimum time and amount of material necessary to be effective.

It has been found that about 25 days is necessary for one generation of the weevils ; also, that they occur in rice ears in the field.

SUGAR

Cane

Leeward Islands.—*Antigua.*—The following particulars are taken from the report by Mr. F. H. S. Warneford, Agricultural Superintendent, Antigua, on investigational work carried out during the period July–December 1933.

The varietal plots, the results from the first reaping of which were contained in the report for the period January–June 1933 (this BULLETIN, 1933, **31,** 406), were reaped for the "late crop reaping" during the period under consideration and the results are recorded in the following tables.

TABLE I

MILLARS

Variety	Date of reaping	Tons cane per acre	Tons sucrose per acre
P O J 2878	19-26/4/33	52·5	Figures not available.
B 117	,,	37·0	
B 11569	,,	36·5	
B H 10/12	,,	36·2	
S C 12/4	,,	36·4	
B 4507	,,	24·6	

Differences greater than 4·3 tons per acre are significant.

TABLE II

FITCHES CREEK

Variety	Date of reaping	Tons cane per acre	Tons sucrose per acre
P O J 2878	26–28/4/33	43·5	6·58
B 11569	,,	37·0	5·0
P O J 213	,,	36·1	4·74
B 4507	,,	34·6	4·82
G 119	,,	33·6	4·60
G 140	,,	29·2	3·52

Both the G canes suffered in yield severely from the high percentage of rotten canes at reaping time.

Differences in tonnage of cane greater than 4·9 tons per acre are significant.

TABLE III

JOLLY HILL

Variety.	Date of reaping.	Tons cane per acre	Tons sucrose per acre
P.O.J.2878	1–4/5/33	23·6	3·1
B 726	,,	23·7	3·8
B 891	,,	21·5	3·3
B.381	,,	20·3	3·0
B H.10/12	,,	20·1	3·2
B.374	,,	19·1	2·7

Differences in tonnage of cane greater than 2·25 tons per acre are significant.

ROOT CROPS

Cassava

Gold Coast.—The report of the Director of Agriculture for the period July to December 1933 contains the following reference to the investigational work on cassava mosaic.

Variety immunity trials have been continued at Kpeve and Aburi, but though there appears to be considerable variation in resistance no immune types have been discovered. Many new varieties have been introduced from other countries and will be subjected to immunity as well as yield and palatability trials. At Kumasi a very large collection of different local types has been made and the Botanist is studying and classifying them. He has evolved a technique of crossing which is giving satisfactory results and is raising a large number of seedling varieties which will later be tested for immunity and other desirable qualities. Mosaic disease is still unknown in the Northern Territories and is not serious in Ashanti, while coastal areas are seriously affected.

Cocoyams

Gold Coast.—The Director of Agriculture, in a report covering the period July to December 1933, states that the investigations on the root rot of cocoyams referred to in previous reports have been continued. Knowledge now available shows that the clearing of bush produces some soil condition favourable to the disease, which is not present in uncleared land or garden soils. Ordinary soil deficiencies and soil reaction are not related to the disease, but denitrification produced by poor aeration and assisted by the presence of decaying roots may be a contributory factor. Rotting bush roots in infected areas produce some agent which is lethal to cocoyam roots, but, as the disease is of comparatively recent origin and as the crop was formerly grown without trouble on cleared land, it would appear that this agent alone is not responsible for the disease, but rather that a parasite is present which can only attack the roots of cocoyams in the presence of certain soil conditions produced by clearing of bush. The Mycologist is now directing his investigations towards the discovery of the nature of the soil condition and isolation of the parasite, which may not be a fungus. A collection of local types of cocoyams has been made on the Agricultural Station at Kumasi where the Botanist is studying their characteristics and resistance to disease with a view to breeding an immune or highly resistant type. Several varieties have been introduced from abroad, but all appear to be equally susceptible to the disease.

FRUITS

General

Gold Coast.—The Director of Agriculture, in a report covering the period July to December 1933, states that a small canning plant has been installed at the Agricultural Station, Asuansi, and canning trials with grapefruit have commenced. Results to date have been satisfactory, the product turned out being of pleasing appearance and flavour. Sufficient time has not yet elapsed, however, to allow the results of storage trials to be known. As grapefruit can be grown locally and purchased at reasonable prices the future of the industry would appear to depend on finding suitable markets for the canned product.

Trials are being planned for the canning of other local fruits and vegetables.

Bananas

Gold Coast.—The Director of Agriculture has furnished the following report on investigations conducted during the period July to December 1933.

Ripening Trials.—With a view to future exports of bananas, ripening trials were conducted at Asuansi. Bunches were harvested at different stages of maturity and careful observations made on the time taken to ripen, the behaviour during ripening and the quality of the ripe fruit. Results indicated that bunches should be harvested in the light-green stage, i.e. after losing the dark-green colour of young bunches. At this stage the proximal fingers have lost much of their angularity, whilst distal fingers show well-defined ridges. More mature bunches ripened unevenly and fresh green bunches were less attractive in appearance and flavour.

Trial Shipment.—In November a trial shipment of 229 bunches, consisting of 212 of the Canary type and 17 of the Gros Michel type, was made from Takoradi. An Agricultural Officer accompanied the shipment to study the behaviour of the fruit in transport and its condition and suitability for ripening on arrival in the United Kingdom. Bunches were packed in three ways: (*a*) in crates, (*b*) in perforated paper bags and (*c*) in trash. The majority were harvested and packed under the supervision of officers of the Department, as local growers have no experience of the correct stage of ripeness or methods of handling. Vaseline was applied to the ends of the main stalk when cut, and the stalks were retrimmed and vaselined immediately before shipment. Each bunch was labelled, and the origin, stage of ripeness when harvested, time of harvesting and other relevant data recorded. Mr. F. A. Robb, the officer who accompanied the shipment, has made a full report on the results of the trial. All bunches reached Liverpool in a sound condition, this being ascribed to careful retrimming and prompt application of vaseline ; six bunches only showed indications of main-stalk rot. Bunches were rated by buyers as well up to the standard, equal to or better than bananas from other countries, and sold rapidly. Much interest was aroused in the market by the arrival of this fruit.

Mr. Robb recommends that bunches should be harvested in the light-green stage and that harvesting should be delayed until the last possible moment ; twenty-four hours before shipment should be considered the maximum time. Of bunches in the trial shipment which had been cut thirty-six hours before being stowed in the cool room 33 per cent. were practically ship-ripe when discharged at Liverpool. The paper-bag method of packing gave the most satisfactory results and with a few minor alterations to the bag its adoption is recommended.

Citrus

Gold Coast.—The following reference to investigations on citrus fruits is contained in the report of the Director of Agriculture for the period July to December 1933.

Field Trials.—Experimental work on citrus fruits is being continued on Agricultural Stations, particularly at Asuansi. Introduced types of lemons are being budded on sour orange and rough-skinned lemon stocks. Bud wood from selected grapefruit and orange trees is being used for propagation of supplies for distribution to progressive farmers.

Citrus Fruit-piercing Moths.—As these moths appear in large numbers only in the months of April, May and June, little progress in investigations into methods of control has been made since the last report was forwarded. Various types of poison baits have been tried out, the most successful being :

Sugar-cane juice	¼ gallon
Water	¾ ,,
Sodium arsenite	$\frac{1}{16}$ oz.

The solution should be changed weekly.

Leeward Islands.—*Dominica.*—Mr. F. G. Harcourt, Agricultural Superintendent, reports that during the half-year ended December 31, 1933, the investigational work classified in the last report under the headings (1) Lime Breeding, (2) Trials of Stocks for Limes, (3) Grapefruit and Orange Variety and Stock Trials and (7) Demonstration Plots at the Experiment Station has continued steadily along the lines described therein (this BULLETIN, 1933, **31**, 413). There are no new developments to report under these headings.

The following headings are, for convenient reference, numbered as formerly. One new item is added.

4. *Estate Development at the Government Fruit Farm.*—The clearing and preparation of land for planting under this scheme, which was briefly described in the report for the half-year ended December 31, 1932 (this BULLETIN, 1933, **31**, 252), has now been completed, and considerable further planting was done during the past year. Earlier plantings are growing well. Work on the general development of the estate, such as the improvement and extension of drainage systems and road-making, is proceeding. Detailed records of the costs of all such operations are being kept.

5. *Plant Distribution.*—The propagation of economic plants continues to be one of the principal duties of the department. The number of grapefruit trees distributed during the year was 8,781, this being an increase of 40 per cent. over the number distributed in 1932. So much of the land best suited for lime-growing having already been replanted, the number of lime trees distributed, 23,643, was less than in the previous year. The distribution of orange trees shows a slight increase. Propagation of trees for planting in 1934 is well in hand. Arrangements have been made to restrict further the production of lime trees and to increase the production of grapefruit and orange trees. Under the Plant Distribution Scheme financed by the Imperial Government, 161,270 budded or grafted fruit trees, 126,357 coffee and 47,491 cocoa plants, together with large numbers of other economic plants, have been propagated and distributed since 1927.

6. *Economic Section of the Botanic Gardens.*—Further progress was made with the remodelling of this section of the gardens and most of the plots formerly occupied by manurial experiments with cocoa have now been cleared. In one of these plots a collection of Avocado pears was planted in 1932. Most of the trees have grown well, and ten varieties appear to be established. The planting of a collection of standard varieties of grapefruit and oranges, mentioned in the last report, was completed.

Other plantings included miscellaneous varieties of citrus, a plot of Tonka beans and a plot of nutmegs. The newly planted plots are also used for the trial of various cover crops, two species proving especially useful being *Indigofera endecaphylla* and *Crotalaria oocarpa.*

8. *Top-working Lime Trees.*—In view of the increasing interest in grapefruit cultivation in Dominica and the possibility of the over-production of lime products in the future it was considered advisable to investigate the possibilities of top-working lime trees with grapefruit. A trial of various methods of top-working trees to determine that best suited to the lime under the climatic and other conditions existing in Dominica, and also the compatibility between the lime and the grapefruit has been started. So far thirty-four trees have been treated. They had been budded on sour orange stocks, the union being about eight inches from the ground. They were planted in 1930, and had grown to a height of about seven feet, with a girth measurement, at the union of stock and scion, averaging nine inches. Many had borne a few fruits. Methods being tried include the following : Cutting back the trees to about eighteen inches from the ground and inserting buds on the resulting new lime shoots ; cutting back to the sour orange stock and budding on the new sour orange shoots ; cutting back and budding on two-year-old lime wood ; cutting back and crown grafting on older lime wood ; cutting back to the sour orange stock and crown grafting. Although on many of the trees the buds or grafts are growing, it is, of course, much too early to draw any conclusions as to the results of this trial. Similar trials on a smaller scale are being conducted with limes on other stocks.

Sierra Leone.—Mr. C. Hargreaves, Entomologist to the Department of Agriculture, in a report on the work carried out during 1932, referred to the problem of fruit-piercing Lepidoptera in relation to citrus fruits (this BULLETIN, 1933, **31,** 85). In his report for the period July–December 1933, he states that further larval hosts of fruit-piercing Lepidoptera have now been found. In addition to *Alchornia cordifolia* and *Phyllanthus discoideus* for *Achæa catocaloides*, *Othreis fullonica* was found in *Tiliacora* sp. near *Dinklagei* and *O. divitiosa* on *Rhagiocarya racemifera* and *Dioscoreophyllum leonense*, the three hosts of *Othreis* belonging to the Menispermaceæ.

There is no doubt that *O. fullonica*, *O. divitiosa* and *O. materna* (which also occurs here), as well as probably all the species of *Achæa*, are migratory.

Owing to the wide distribution of the main host plants, it will not be practicable to attack these pests from this standpoint, so that attention will have to be given to either limiting the fruiting season to the period October to February, or dealing with the adults by means of poisoned baits, as described in the previous report.

MINERAL RESOURCES

CYPRUS

The Imperial Institute has received from the Colonial Secretary the following statement in regard to the mining operations carried out in Cyprus during the six months ended December 31, 1933.

Due to the sustained improvement in trade conditions and to the greater demand for minerals, mining activities in the Colony have shown an appreciable increase during the six months under review. The larger operating mines have been able to carry on without intermission, and to employ an increased number of persons, while prospects for the future appear to be distinctly good.

The Mavrovouni mine, having completed its development programme, will not be working at full pressure until the new metallurgical plant is finished. The following tables indicate the work carried out by the various mining concessions in the island :

Work done by the Cyprus Mines Corporation at the Skouriotissa Pyrites Mines

	Second 6 months 1933.	Second 6 months 1932
Underground development, footage . . .	2,463	607
Tonnage mined	91,379	20,256
Underground labour (average per day) . .	562	178
Tonnage exported	90,680	48,592
Labour, surface and underground (average per day)	734	640

Work carried out at the Mavrovouni Pyrites Mine by the Cyprus Mines Corporation

	Second 6 months 1933.	Second 6 months 1932.
Underground development, footage . . .	3,530	13,693
Tonnage mined	11,370	59,072
Underground labour (average per day) . .	100	324
Tonnage exported	7,301	56,125
Labour, surface and underground (average per day)	339	559

WORK DONE AT THE LYMNI MINE OF THE CYPRUS SULPHUR AND COPPER CO LTD

		Second 6 months 1933	Second 6 months 1932
Underground development, footage		Nil	Nil
Opencast, overburden removed	*cub yds*	Nil	1,966
Tonnage mined		Nil	239
Copper precipitate produced	*tons*	7½	1
Labour (average per day)		3	61

WORK DONE AT THE TROODOS MINES OF THE CYPRUS CHROME CO LTD. (MINING LEASE AND PROSPECTING PERMITS AREAS)

	Second 6 months 1933	Second 6 months 1932
Development, total footage	1,063	752
Tonnage mined	Nil	287
Tonnage exported	Nil	Nil
Labour (average per day for 4 months)	52	51

WORK DONE BY THE CYPRUS MINES CORPORATION AT THE SKOURIOTISSA MINES

	Second 6 months 1933	Second 6 months 1932
Underground development, footage	8,580	Nil
Tonnage mined (auriferous andesite)	2,342	1,073

WORK DONE BY THE CYPRUS AND GENERAL ASBESTOS CO LTD (FORMERLY CYPRUS ASBESTOS CO LTD), AMIANDOS

		Second 6 months 1933	Second 6 months 1932
Rock mined	*tons*	238,002	100,920
Rock treated	*tons*	52,958	24,763
Finished asbestos produced	*tons*	2,277	1,161
Finished asbestos exported	*tons*	3,386	833
Average daily labour (quarries only)		625	145
Average daily labour (all operations)		1,080	341

WORK DONE BY THE HELLENIC COMPANY OF CHEMICAL PRODUCTS AND MANURES (LEASE ON TROODOS)

		Second 6 months 1933	Second 6 months 1932
Rock mined	*tons*	Nil	Nil
Rock treated	*tons*	Nil	Nil
Finished asbestos produced	*tons*	Nil	Nil
Finished asbestos exported	*tons*	Nil	Nil
Average daily labour (quarries only)		20	Nil
Average daily labour (all operations)		46	Nil

Note —This lease has been in operation for 3 months only

Minerals exported, other than those dealt with above, were as follows:

		Second 6 months 1933	Second 6 months 1932.
Gypsum, calcined	*tons*	5,015	4,407
Gypsum, raw	*tons*	1,085	1,122
Stone, building	*cub yds*	2	667
Stone, pumice	*tons*	99	Nil
Terra umbra	*tons*	2,540	1,469
Terra verte	*tons*	7	3

GOLD COAST

The Imperial Institute has received from the Director the following account of the work carried out by the Geological Survey during the six months ended December 31, 1933.

During the greater part of the period under review the Director and Geologists were on leave and engaged in research work on the material collected during the previous field tour. One Geologist was in the field for 2½ months and the Director and the other Geologist for one month. During his leave the Director attended the International Geological Congress in the United States and visited the principal mining districts in the eastern and south-eastern states.

The investigation of the gold resources of the Colony and Ashanti was continued, and by the end of the year this work was nearly completed as far north as the latitude of Kumasi. Numerous prospects, some of which are worthy of further investigation, were examined and very fair prospects of gold were found in a few places where no previous work had been done.

Geophysical investigations carried out across the Prestea auriferous belt between Anfargah and Broomassie and near Bogosu, and across the Bowiye range on the motor road south-east of Nkunsia, proved the existence of several striking anomalies. Some of the anomalies are associated with known auriferous reefs, but others are in places where there are no visible surface indications of reefs. These need investigation by pitting and trenching. The report on the geology of the Prestea goldfield (*Memoir No.* 3 of the Geological Survey) is now in the press.

To show the relationship between the geology and the principal gold and manganese deposits, a geological map (scale 1 : 125,000) of the country extending from the coast between Twin Rivers and the Pra to beyond the railway line from Kumasi to Bompata, has been prepared.

The revision of the geological map of the Gold Coast has also been put in hand and the southern section is nearly completed.

Analyses of the waters of Lake Bosumtwi and of the agglomerate and scoria found in the vicinity of the lake indicate that they are of volcanic origin and confirm the results previously obtained in the field.

NIGERIA

The Imperial Institute has received from the Director the following account of the work carried out by the Geological Survey during the six months ended December 31, 1933.

Gold.—Although no investigations have been carried out by the Department during the period under review it is interesting to note the increasing production and activity on the Goldfield. Owing to the restriction on the output of tinstone and the high price of gold, activity has been renewed in this field, which a year or two ago was almost entirely neglected, and the industry promises to become an important one for Nigeria. It is expected that the gold won during 1933 will exceed 17,000 ounces and much new ground is being pegged. A series of topographical sheets on which the geology has been superimposed, and embracing a large part of the field, has been published, together with a short explanatory pamphlet.

Lead-Zinc.—Some investigations were carried out in the neighbourhood of Abakaliki to test the Spontaneous Polarising method of geophysical prospecting on the lead-zinc lodes known to occur there. Some interesting results have been obtained which seem to indicate that this method may be of considerable value in tracing the underground extensions of lodes which do not reach the surface. Further tests are necessary, however, before any definite pronouncement can be made.

Water.—Water-supply work has been continued in the Northern Provinces in the Emirates of Sokoto, Bornu, Katsina, Hadejia, Gumel and Daura. During 1933, the footage sunk was 20,899 feet, as a result of which 176 wells were brought into production. The majority of these are of the usual 4 feet internal diameter while others are 3 feet in diameter.

In Bornu Emirate, the programme of development of the area adjacent to the Belle-Maiduguri road has met with success. This vast area contains much good pasture land through which there are many important trade routes. Lack of permanent supplies of water had hitherto hindered development and led to the migration southwards in the dry season of thousands of cattle which graze there during the rains. Water lies deep in this area as a rule ; and as it is situated far from railhead, wells of 3 feet internal diameter have been constructed in order to reduce costs. Fortunately it has been possible in most cases to carry the shafts down to pressure water and big yields are being obtained. The programme is not yet complete and will be continued in 1934.

In Sokoto, work has been continued in the bush areas to the south-west of the town. During the rains a considerable amount of trouble was caused by perched aquifers and swelling shales which retarded progress.

In the Emirates of Hadejia, Gumel and Daura, which comprise the Northern Division of Keno Province, much progress has been made during the past half-year. In Hadejia the programme first commenced in 1931 has been completed for the present and 81 wells have been brought into production. In Gumel, the shafts are deeper than in the neighbouring Emirates and 3,350 feet of sinking accomplished during the year has resulted in 20 producing wells while 6 are in the course of construction. Work, which was not commenced in Daura till October, has produced 1,200 feet of sinking and 12 shafts in water.

In Katsina Emirate progress has been steady and satisfactory. Some difficulty has been experienced in a few wells owing to the fact that crystalline rocks have been encountered at depth which, although buried under a cover of sediments, lie above the general level of the water-table of the district. During the year, however, a footage of 4,475 feet has been obtained and 33 shafts were sunk to water.

UGANDA

The Imperial Institute has received from the Director the following account of the work carried out by the Geological Survey during the six months ended December 31, 1933.

As one of the two Field Geologists had to be brought in to Headquarters to take the place of the Senior Assistant Geologist who went on leave to England, and as the other Field Geologist was seconded to the Mines Department for three months, the work of this Survey was severely curtailed. This was particularly unfortunate in view of the rapidly spreading interest in mineral development in Uganda.

Several promising discoveries of gold, tin and tantalite have been made, and the preliminary investigation with regard to the deposition of Pleistocene alluvials in relation to earth-movements and climatic changes has been brought to a stage of completeness sufficient to warrant publication in detail. It seems unlikely, however, that funds will be available for this.

Mr. A. D. Combe has completed his preliminary investigation of an area in Ankole which was closed against prospecting on account of his discovery of promising gold therein, and a short report upon it will shortly be published for the benefit of those who wish to apply for an exclusive licence over the area.

Dr. K. A. Davies has completed his preliminary field studies of the auriferous area near Busia, in the Eastern Province, of which he was the discoverer.

Indications of gold in Buganda have been found by this Survey, and coarse gold with nuggets up to two or three ounces in weight have been found in several places by prospectors in the south-west of the Protectorate.

During 1933, 53 Exclusive Prospecting Licences were taken out (as against 12 in 1932) and 95 mining claims (as against 15 in 1932).

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Investigations on the Infestation of *Peridermium himalayense* Bagchee, on *Pinus longifolia*. Part II. *Cronartium himalayense* n. sp., on *Swertia* spp. Distribution, Morphology of the Parasites, Pathological Study of the Infection, Biological Relationships with the Pine Rust and Control. By K. Bagchee. *Indian For. Rec., Botany Series*, 1933, Vol. XVIII, Pt. XI. Pp. 66 + 17 Plates, 9¾ × 7½. (Delhi: Manager of Publications, 1933.) Price Rs. 4–4 or 7*s*.

Regeneration and Management of Sal (*Shorea robusta* Gaertn. f.). A Survey of the Problems Presented and Proposals for Necessary Further Investigations. By H. G. Champion. *Indian For. Rec., Silviculture Series*, 1933, Vol. XIX, Pt. III. Pp. 159, 9¾ × 7½. (Delhi: Manager of Publications, 1933.) Price Rs. 5 or 8*s*. 3*d*.

Eenige Orienteerende Bemestingsproeven met Djati. By I. C. Coster. *Korte Med. No.* 37, *Dept. v. Landb., Nijverheid en Handel, Ned.-Indïe.* Pp. 21, 9¾ × 6. (Buitenzorg: Archipel Drukkerij, 1933.) Reprinted from *Tectona,* 1933, No. 9. With summary in English. An account of some manuring experiments with teak.

Timbers

Glossary of Terms Used in Describing Woods. Compiled by the Committee on Nomenclature, International Association of Wood Anatomists. *Trop. Woods* (1933, No. 36, 1–12).

The Physical and Mechanical Properties of Woods Grown in India. Third Interim Report on Project I (Tests on Small Clear Specimens, including Results of Work done up to the end of 1932). By V. D. Limaye and L. N. Seaman. *Indian Forest Records, Econ. Series,* 1933, Vol. XVIII, Part X. Pp. 70, 9½ × 7½. (Delhi: Manager of Publications, 1933.) Price Rs. 4-4 or 7*s.*

Die Holzvergasung und ihre Bedeutung fur Koloniale Gebiete. By Dr. Von Monroy. *Tropenpflanzer* (1934, **37,** 3–12).

Stone in Iroko (*Chlorophora excelsa* B. and H.). By C. M. Harris. *Emp. For. Journ.* (1933, **12,** 229–238). Description, occurrence, cause and composition of stone-like concretions in this timber.

How Lumber is Graded. By H. S. Betts and R. K. Helphenstine. *Dept. Circ. No.* 64, *U.S. Dept. Agric.* Pp. 47, 9 × 6. (Washington, D.C.: Superintendent of Documents, Government Printing Office, 1933.) Price 5 cents.

Types of Timber-seasoning Kilns. By I. H. Boas *Trade Circ. No.* 17, *Div. For. Products, Counc. Sci. Indust. Res., Australia.* Pp. 18, 9½ × 6. (Melbourne: Government Printer, 1933.)

Heating Value of Wood Fuels. By J. D. Hale. *Issued by the Forest Products Laboratories of Canada.* Pp. 13, 10 × 8. (Ottawa: Forest Service, Department of the Interior, 1933.) Mimeographed copy.

The Durability of Western Red Cedar (*Thuya plicata*). By W. P. K. Findlay. *Emp. For. Journ.* (1933, **12,** 239–240).

The Working Qualities and Resistance to Decay of Western Hemlock (*Tsuga heterophylla* Sarg.) from British Columbia. *Investigation No.* 9, *Project* 23, *For. Prod. Res. Lab., Dept. Sci. Indust. Res.* Pp. 13, 9½ × 7½. (Princes Risborough, Bucks: Forest Products Research Laboratory, 1933.) Mimeographed copy.

Studies in the Decomposition of Timber under Industrial Conditions. II. The Decay of Greenheart. By E. A. Rudge. *Journ. Soc. Chem. Indust.* (1933, **52,** 447T–449T).

Studies in the Decomposition of Timber under Industrial Conditions. III. Pitchpine. By E. A. Rudge. *Journ Soc. Chem. Indust.* (1934, **53,** 22T–24T).

Testing and Selection of Commercial Wood Preservatives. By S. Kamesam. *For. Bull. No.* 81, *Econ. Ser , For. Res. Inst., Dehra Dun, India.* Pp. 40, 9¾ × 7¼. (Delhi: Manager of Publications, 1933.) Price As. 14 or 1*s* 6*d.*

The Prevention of Decay in Building Foundations. *Trade Circ. No.* 18, *Div. For. Prod., Counc. Sci. Indust. Res., Australia.* Pp. 14, 9½ × 6. (Melbourne: Government Printer, 1933.)

Effect of Steam Sterilization on the Susceptibility of Wood to Blue-staining and Wood-destroying Fungi. By A. D. Chapman. *Journ. Agric. Res.* (1933, **47,** 369–374).

Blue Stain in *Pinus radiata* (*insignis*) Timber. Some Preliminary Experiments with Case Stock. By J. E. Cummins. *Journ. Counc. Sci. Indust. Res., Australia* (1933, **6,** 244–252).

The Effect of Kiln Temperatures and Air Seasoning on Ambrosia Insects (Pinworms). By G. R. Hopping and J. H. Jenkins. *Circ.* 38, *Forest Service, Dept. Inter., Canada.* Pp. 14, 9¾ × 6½. (Ottawa: Director of Forestry, 1933.)

Tests of the Resistance to Marine Borer Attack of some Malayan Timbers Untreated and Treated with Preservatives. *Malayan Forester* (1933, **2**, 179–182).

Gums and Resins

The Importance of Lac Research in Relation to the Use of Lac Products in Modern Industry. By A. J. Gibson. *Oil and Colour Trades Journ.* (1934, **85**, 247–254).

Tanning Materials

La Mangrove Congolaise. By L. Pynaert. *Bull. Agric., Congo Belge* (1933, **24**, 185–207). An account of the mangrove forest of the Congo.

La Valonea ed il suo Tannino. By L. Todeschini. *Bull. Uff. R. Staz. Sperimentale per l'Indust. delle Pelli e delle Materie Concianti* (1933, **11**, 541–547).

Wattle Production in the Union. By I. J. Craib. *Farming in S. Africa* (1933, **8**, 423–426).

NOTICES OF RECENT LITERATURE

Books for review should be addressed to "The Editor," Bulletin of the Imperial Institute, South Kensington, London, S.W.7.

INLAND WATERS OF AFRICA. By S. and E. B. Worthington. Pp. xix + 259, 9 × 6. (London: Macmillan & Co., Ltd., 1933.) Price 15*s*.

This attractive volume is sub-titled "The Result of Two Expeditions to the Great Lakes of Kenya and Uganda, with Accounts of their Biology, Native Tribes and Development." This sub-title indicates the particular region dealt with, and the wide scope of the work, but it is difficult in a brief notice to give any adequate idea of the mass of information which it contains or the admirable way in which the matter is presented.

Dr. and Mrs. Worthington both took part in the Cambridge expedition to the East African lakes in 1930–31, and the present work is largely based on their experiences on that occasion, but it also includes information obtained by Dr. Worthington and his colleagues in a previous expedition in 1927–28. The authors explain in their Foreword that they have endeavoured to combine the popular and more strictly scientific aspects of their subject, and it can only be said that this difficult task has been very successfully carried out, for whilst the book contains much information which will be welcomed by the scientific reader, it is at the same time written in such a way, and with such a large amount of popular (and not infrequently humorous) description of scenes and phenomena, that the ordinary reader interested in African travel will find it a fascinating work.

The authors describe the past and present geology of the region and its possible bearing on future conditions; the scenery and climate; the inter-relation and other aspects of plant and animal life, especially the conditions of fish life in the lakes; and the industries and social customs of the natives. They deal in some detail with the native lake fisheries, which are of considerable economic importance, and devote an entire chapter to an account of the successful introduction of European trout into the upland waters of Kenya. A number of excellent photographs add to the interest and value of the volume.

THE DISCOVERERS OF THE FIJI ISLANDS. Tasman, Cook, Bligh, Wilson, Bellingshausen. By G. C. Henderson, M.A., Emeritus Professor of History, Adelaide University. Pp. xviii + 324, 9 × 6. (London: John Murray, 1933.) Price 18*s*.

In this volume Professor Henderson has furnished a treatise which may perhaps appeal to a rather limited class of readers, but is in itself of great interest and forms a valuable record of achievements in the field of navigation. It gives accounts of various voyages of the explorers mentioned in the sub-title, including extensive quotations from their own writings, and is well illustrated with charts, portraits and photographs. The work is the result not only of personal observations made by the author during a series of voyages to Fiji, but also of a large amount of painstaking research.

In his Preface the author acknowledges the assistance received during his voyages from commanders and navigators of British and Colonial ships, whose special training was of great use to him in testing statements found in the log-books and charts of the explorers. He expresses the hope that " as a result of these advantages, in addition to my academic researches, it will be found that the information given in this book is reliable; and also that my wholehearted appreciation of the character and work of every one of the discoverers, founded as it is upon vital knowledge of the difficulties and dangers which they encountered, is just."

THE SOUTH AND EAST AFRICAN YEAR BOOK AND GUIDE FOR 1934. Edited for the Union-Castle Mail Steamship Co., Ltd., by A. Samler Brown, F.R.Met.S., and G. Gordon Brown, F.R.G.S. Pp. lxiv + 1129, 7 × 5. (London: Sampson Low, Marston & Co., Ltd., 1934.) Price 2*s*. 6*d*.

The issue of this annual volume for 1932 received a short notice in this BULLETIN (1932, **30**, 96). The present edition contains some 200 pages more than that of 1932, but the price is the same, and the book is undoubtedly one of the cheapest compendiums of geographical and economic information available. A "desk section" of over 50 pages is included for the first time, giving information on postal matters, taxation, local weights and measures, currencies, Government officials, etc., in the countries dealt with.

In the sections on economic products on pp. 278–431 the term "South Africa" is used to cover far more than the Union and to include even Portuguese territory (e.g. on p. 308), and the way in which information regarding the Union itself is intermixed with that of other countries is somewhat confusing in places. It is suggested that in future issues some new arrangement of type or subheadings might usefully be introduced in order to obviate the confusion.

RAILWAY AND CUSTOMS POLICIES IN SOUTH AFRICA, 1885–1910. By Jean Van Der Poel, M.A., B.Ed., Ph.D. Pp. 151, 8¾ × 5½. (London, New York, Toronto: Longmans, Green & Co., 1933.) Price 7*s*. 6*d*.

This treatise, originally compiled as a thesis for the degree of Ph.D. in the University of London, has been issued under the auspices of the Imperial Studies Committee of the Royal Empire Society. The author points out in his Preface that the story of the development of the South African railways is primarily a political one, and that the history of South Africa from 1885–1910 turns on the conflicting railway and customs policies of the various states and colonies concerned.

The book is likely to be of interest mainly to students of South African history and economic development, and may thus not have a very wide appeal, but it contains a mass of well-collated information which should make it a useful work of reference.

A FOSSICKER IN ANGOLA. By Malcolm Burr, D.Sc., A.R.S.M., F.R.E.S. With a Preface by Henry W. Nevinson. Pp. 200, 8½ × 5½. (London: Figurehead, 1933.) Price 5*s*.

This account of a tour in the Portuguese Colony of Angola, whilst written in a light and entertaining style, furnishes in the course of the narrative much interesting information about a large but little-known territory. The author undertook his journey in search of coal measures, but he makes little reference to his professional duties and deals mainly with such matters as entomology, zoology, and the human life of the country. The book gives an attractive picture of a tropical region now traversed by an important new line of railway and consequently in a stage of active economic development.

THE FOUNDATIONS OF AGRICULTURAL ECONOMICS. Together with an Economic History of British Agriculture during and after the Great War. By J. A. Venn, Litt.D., President of Queens' College, Cambridge. Pp. xx + 600, 9½ × 6½. Second Edition. (Cambridge and London: The Cambridge University Press, 1933.) Price 25*s*.

The author of this volume is Gilbey Lecturer in the History and Economics of Agriculture in the University of Cambridge, and the material here presented is based largely on his lectures to third-year and diploma students at the University School of Agriculture. The book is essentially a treatise on British agriculture, dealing with its history as well as present conditions, but some of the chapters are concerned also with the marketing of agricultural products in the Dominions, the question of co-operation, and other matters affecting agricultural countries in general. In view of the great importance and interest of its subject this second edition of Dr. Venn's authoritative and illuminating work should find appreciative readers in all parts of the Empire.

THE PLANNING OF AGRICULTURE. By Viscount Astor and Keith A. H. Murray. With a Foreword by Sir Arthur Salter. Pp. xvi + 186, 8½ × 5½. (Oxford: The University Press; London: Humphrey Milford, 1933.) Price 6*s*.

This is primarily an account of British agriculture in recent years, and the steps taken by Government to develop and organise the industry. In places there is a tendency to discursiveness which detracts somewhat from its value as an objective survey, but the authors have furnished a large amount of useful information, clearly and concisely presented, together with well-reasoned comments on various aspects of their subject.

The book is written mainly for perusal in the United Kingdom, but it contains many references to Empire conditions and the repercussions of the Ottawa Agreements. It is obviously desirable that overseas agriculturists should be aware of the relation of these Agreements to the situation in Great Britain, and the work might usefully find a place in agricultural libraries throughout the Empire.

WORLD SUGAR PRODUCTION AND CONSUMPTION. An Economic-Geographical Survey. By C. J. Robertson, B.Sc., M.A., Ph.D. Pp. vi + 142, 7¼ × 4¾. (London: John Bale, Sons and Danielsson, Ltd., 1934.) Price 5*s.*

The scope of this volume is indicated in the brief Foreword by Mr. Noel Deerr, who points out that whilst there are many books on the technicalities of sugar manufacture there are but few concerned with the vitally important economics of its production. In Mr. Deerr's opinion the author's presentation of such matters as the effect of climate, density of population, tariffs, relationship to research and many other controlling factors " leaves little to be desired."

The first three chapters are devoted to an outline of the world's trade in sugar, and the general conditions of cane- and beet-sugar production. Then follow seven chapters on the conditions and problems of the sugar industry in the chief producing areas of the world. The three remaining chapters deal with the refining industry, the factors affecting the demand for sugar and the prospects of world production and consumption.

The author discusses the various points to be considered in assessing the cost and the relative advantages of cane- and beet-sugar production and comes to the conclusion that " consideration of the potentialities of cane-sugar and beet-sugar production strengthens the view that the proportion of the world's total sugar consumption supplied by cane is likely to show a continued upward trend. While the advantages mentioned may, with the continued assistance of tariffs and other methods of protection, maintain the beet area, there are limits to the costs bearable in the countries concerned by public funds and domestic consumers in the attempt to neutralise geographical realities."

The book should be of value to all interested as producers, economists or geographers in this great industry.

COFFEE FROM GROWER TO CONSUMER. By B. B. Keable. Revised by C. J. Parham. Third Edition. Pp. vii + 124, 7¼ × 4⅜. (London: Sir Isaac Pitman & Sons, Ltd., 1933.) Price 3*s*.

Although coffee is one of the most important of tropical products there are very few books dealing with it in a comprehensive manner. This work, now in its third edition, goes far to fill the want for the general reader. The authors recount the history of coffee and then deal with the various species, methods of cultivation and preparation of the produce for export, the chief coffee-growing countries, marketing and preparing for the consumer, and the value of coffee in the human dietary.

Whilst the greater part of the information given is excellent and accurate there are several matters which call for revision in a future edition. In Chapter I it is stated (p. 12) that only two species of coffee, Arabian and Liberian, are cultivated to any great extent, but that (p. 18) experiments are being made with others, e.g. Robusta, in the hope of finding one " fit for cultivation." The fact that of the exports of 70,000 tons from the Dutch East Indies in 1931 nearly 90 per cent. was Robusta is not mentioned.

On p. 54 Ceylon is included as one of the chief Empire coffee-producing countries, in sharp contrast to the statement (p. 57) that to-day Ceylon coffee is hardly known as an article of commerce. Again (p. 92) under blending we are assured that a Ceylon planter would not think of importing other kinds to mix with the home product in spite of it having been pointed out (p. 11) that the output in 1930–31 was only 112 cwts. Actually Ceylon imports about 1,300 tons per annum.

The account of production in East and Central Africa needs thorough revision. The position in Uganda, for example, is not adequately dealt with merely by the two statements, both on page 61, that as other parts of Africa are opened up, e.g. the outlying parts of the Uganda Protectorate, etc., coffee will be introduced, and immediately below under the heading *Kenya Colony*—total acreage under coffee in Uganda (1931) 39,214. It may be mentioned that over half of this is Robusta. In the chapter entitled " Coffee Production in the British Empire " there seems no reason, beyond that of copying the previous edition, why successive paragraphs should be headed *Kenya*

Colony, Netherland East India Coffee, Kenya Coffee, Colombian Coffee.

In spite of these and some other defects the book does afford a useful general account of the production and use of coffee.

UKERS' TEA AND COFFEE BUYERS' GUIDE. By William H. Ukers, M.A. Seventh Edition, 1934–35. Pp. 192, 7½ × 5. (New York: The Tea and Coffee Trade Journal Co., 1934.) Price $2·00.

Although this book has been prepared primarily for the use of packers and distributors of tea, coffee, spices and grocery products in the United States, it will prove of value to all interested in these trades. In addition to lists of firms engaged in these and ancillary trades in the States, it contains short " essays " on tea and coffee, tables showing the characteristics of the principal kinds of tea and coffee grown in the various countries, explanations of terms used in the tea and coffee trades, the addresses of tea and coffee associations in the principal producing and importing markets of the world and various tables of statistics.

JUTE AND SUBSTITUTES. By N. C. Chaudhury, late of the Provincial Agricultural Services, Bengal and Bihar and Orissa. Third Edition. Pp. xi + 249, 8¾ × 5¼. (Calcutta: W. Newman & Co., Ltd.; London: Gordon & Gotch, 1933.) Price Rs. 10 (15s.).

Two previous editions of this useful book were published in 1908 and 1921 respectively under the title *Jute in Bengal*, and the last edition was reviewed in this BULLETIN (1921, **19**, 431). The author considers the title for the present revised edition more comprehensive and appropriate, but actually only one chapter of 16 pages is devoted to jute substitutes. The author, who has devoted his life to the study of jute, deals authoritatively with every aspect of the subject, from cultivation and research work on different races of jute to its commerce and industry. The general arrangement of the book has been maintained, and the statistics brought up to date. Useful additions have been made to a few of the chapters, and some fresh statistical tables added. Two very short chapters on spinning and weaving are new to this edition, as are also chapters on the introduction of jute into other countries, and the organisation and functioning of co-operative societies. This work will continue to be of value to all who are interested in any phase of the jute industry.

JUTE ANNUAL, 1933. Edited by R. J. Arnott, M.A., and H. F. Tysser. Pp. 128, 10 × 7½. (London: The British-Continental Press, Ltd.). Price 12*s*. 6*d*.

This useful annual, which like its predecessors is printed in English and German, has now reached the third year of publication. In addition to the information usually to be found in trade annuals, such as particulars concerning the various trade organisations throughout the world, statistical tables, and a directory of firms who are either engaged in the industry or who supply machinery and commodities employed by jute manufacturers, this publication contains a number of articles of interest.

The opening article discusses the questions of the effect of the general shrinkage in world trade, and the competition of substitutes, on the serious reduction in the demand for jute. As in previous years an account is given of the position of the jute trade in different countries, and particulars are also supplied regarding enquiries which have taken place under the auspices of a sub-committee of the Indian Jute Mills Association on competition from other goods, research, expansion of the markets for jute goods, and the reorganisation of jute " Futures." One article draws attention to the importance of jute research and mentions some of the successes which have already been obtained in this connection. Other articles deal with new or lesser known uses for jute; the waterproofing and fireproofing of jute fabrics; fertilisers and the sack trade, and the future of linoleum.

MODERN TEXTILE MICROSCOPY. By John Massey Preston, B.Sc., A.I.C., F.R.M.S. Pp. xi + 315, 8¾ × 5½. (London and Manchester: Emmott & Co., Ltd., 1933.) Price 15*s*.

The increasing importance of microscopy as an aid to the study of textile fibres has induced the author, who is a lecturer to the Department of Textile Chemistry, College of Technology, Manchester, to produce the present work. The opening chapters deal at length with the microscope, and the type of instrument most suitable for textile work. Details are given of the methods of preparation and mounting of fibres, the various methods for obtaining cross-sections of fibres, and their application to the identification of different varieties or qualities of rayon, silk, wool, cotton and linen. The production of illustrations of microscopical specimens, by drawing methods and by photographs, is described. Methods are also given for the measurement and enumeration of microscopic objects and their practical application, as, for instance, in determining the degree of mercerisation of cotton and the spinning quality of wool. Other chapters deal with photographic methods of measuring the amount of light reflected or transmitted by a textile fibre, and spectro-photometric measurements. Methods of steaming and the action of swelling agents are described as a means of identifying fibres, and also as aids to the discovery of the process employed in their preparation, and for the detection of damaged fibres. Further chapters are concerned with the investigation of fibres with the ultramicroscope or by dark-ground illumination, the examination of surface structures, and the application of fluorescent light and polarised light to this type of research.

The book is well produced, contains 134 diagrams and illustrations and is provided with an excellent bibliography. It will undoubtedly prove of considerable value to those practically engaged in the textile industry.

TEXTILES AND THE MICROSCOPE. By Edward Robinson Schwarz. Pp. xi + 320, 9 × 6. (New York: McGraw Hill Book Company, Inc.; London: McGraw-Hill Publishing Co., Ltd., 1934.) Price 24*s*.

The need for bringing together the information which has accumulated in recent years on the developments of micro-analytical technique has been evident to many workers associated with textile research. In the present volume the author has attempted to place the results of his experience in the application of microscopy to textile research in " concise and usable form."

A large portion of the book is devoted to types of microscopical and photomicrographic apparatus, the accessories for use in textile microscopy and manipulative technique. The remaining chapters deal with the application of polarised light and its importance in the theoretical and practical aspects of textile research, and the use and value of the microscope for the analysis of fabric, yarn and fibre. A series of photomicrographs, illustrating the structure of the commoner animal and vegetable fibres, and notes on staining and reagents, are given in an appendix. There is also a useful bibliography containing some 350 entries.

The book is well printed and copiously illustrated; it should be of value to all engaged in textile technology and prove an incentive to further original study of this subject.

VIRUS DISEASES OF PLANTS. By John Grainger, Ph.D., B.Sc. Pp. viii + 104, 7½ × 5. (Oxford : The University Press ; London : Humphrey Milford, 1934.) Price 6*s.*

This useful little book will achieve its object of introducing to the student the phenomena associated with virus diseases. It is a practical, simply-worded primer of a subject in a state of rapid development, and through the agency of an extensive and well-chosen bibliography, comprising some 445 references, forms a valuable index to the present state of knowledge of plant virus pathology.

The study of virus diseases has made great strides during the past 25 years and it is now possible to distinguish three types of symptoms, viz. " mosaic," involving mottling of leaves with or without malformation, transmission being by mechanical or biological methods ; " yellows," showing general chlorosis with clustering or upstanding habit of the young leaves and transmissible by biological means only ; and a miscellaneous group with transmission by mechanical or biological agents or by both. These classes are concisely described in a chapter on the relation of a virus to its host plant which also indicates briefly essential points in connection with transmission, histology and cytology, physiology and developmental anatomy. Succeeding sections deal with the properties of the virus extract in relation to heat, disinfectants, oxygen, ageing, filtration and probable chemical nature. The important part played by insect vectors in the spread of virus maladies is indicated and the technique of experimental transmission described in a further chapter followed by an account of economic effects of the diseases and measures of control. Subsequent chapters deal with the classification and description of virus diseases and general experimental work, and the book concludes with the useful bibliography mentioned above.

NATURE TEACHING. Based upon the General Principles of Agriculture for the Use of Schools. By Sir Francis Watts, K.C.M.G., D.Sc., F.I.C., F.C.S. Sixth Edition. Pp. vii + 216, 7½ × 5. (London : The West India Committee, 1934.) Price 3*s.* 6*d.*

It is unnecessary to give any detailed account of the scope of this book, first published in 1901 and now in its sixth edition. Watt's *Nature Teaching* was one of the early works of its kind, and its value to teachers, particularly in West Indian schools, for whom it was written, is thoroughly well established.

FORESTRY FOR WOODMEN. By C. O. Hanson, I.S.O., M.B.E., F.R.E.F.S. Third Edition. Pp. 237, 7½ × 5. (Oxford: The Clarendon Press; London: Humphrey Milford, Oxford University Press, 1934.) Price 6*s.* 6*d.*

It is twelve years since the last edition of this book was published and the experience that has been gained during this period has necessitated many alterations in detail in order to bring it up to date, whilst the chapters on planting, nursery management, insects and fungi have been partly re-written. In its revised form it will continue to fulfil the purpose for which it was originally designed, that is, of supplying a cheap book on scientific lines for the working forester and woodman. It might be suggested that any future edition should include a select list of references to more complete treatises as a guide to those who wish to read further into the subject.

FOREST TREES AND TIMBERS OF THE BRITISH EMPIRE. II—TWENTY WEST AFRICAN TIMBER TREES. By L. Chalk, M.A., D.Phil., J. Burtt Davy, M.A., Ph.D., H. E. Desch, B.Sc., M.A., and A. C. HOYLE, B.Sc., M.A. Pp. 108, 9½ × 6. (Oxford: The Clarendon Press; London: Humphrey Milford, Oxford University Press, 1933.) Price 7*s.* 6*d.*

The general scope of this series has been indicated in the notice of Part I dealing with East African Leguminosæ and Coniferæ which appeared in this BULLETIN (1932, **30,** 392). The plan and arrangement of the text in Part II now published is on the same lines, except that a few alterations in form have been made, a brief discussion of each genus, with an indication of characters distinguishing it from allied genera, now preceding the account of the species concerned. An important feature is the fact that the descriptions of the species are new, being founded on a large amount of new botanical material received from the Forest Services in West Africa which has cleared up obscure points and afforded a better idea of the range of variation within the species. In addition the same staff have furnished photographs and notes on habits, vernacular names, habitats and local uses of the species. Some changes in terminology have been made in the wood descriptions in accordance with the recommendations put forward by the Committee of the International Association of Wood Anatomists.

The species described are *Holarrhena wulfsbergii* Stapf, *Afzelia africana* Smith, *A. bipindensis* Harms, *Hymenostegia afzelii* Harms, *Terminalia superba* Engl. and Diels, *T. ivorensis* A. Chev., *T. glaucescens* Planch., *T. sokodensis* Engl., *Ricinodendron africanum* Muell. Arg., *Garcinia mannii* Oliv., *Ochrocarpus africanus* Oliv., *Lovoa klaineana* Pierre, *Pseudocedrela kotschyi* Harms, *Piptadenia africana* Hook. f., *Lophira alata* Banks, *L. alata* var. *procera* Burtt Davy, *Mitragyna stipulosa* (DC.) O. Kuntze, *Irvingia gabonensis* Baill., *Cistanthera papaverifera* A. Chev., *Holoptelea grandis* Mildbr.

It will be seen that the selection includes important commercial timber species, but lesser-known woods are also described on the grounds that they seem likely to be more widely used in the future or to be confused with other species described. A considerable number of the more important commercial timbers have been examined at the Imperial Institute and reported on by the Advisory Committee on Timbers and reference is made throughout to the work done in this respect. Among these species are Ekki (*Lophira alata* var. *procera* Burtt Davy), Agboin (*Piptadenia africana* Hook. f.), African walnut (*Lovoa klaineana* Pierre ex Sprague), Afara (*Terminalia superba* Eng. & Diels), Black Afara (*Terminalia ivorensis* A. Chev.), Aligna (*Afzelia africana* Smith), Danta (*Cistanthera papaverifera* A. Chev.), Dika-nut tree (*Irvingia gabonensis* Baill.), and Abura (*Mitragyna stipulosa* (DC.) O. Kuntze).

Reference is made to the uses of the tree other than for timber and for this information the authors have had recourse to the published reports of the investigations at the Imperial Institute, which are included in the valuable bibliography which is a most useful feature of the work. The line drawings of botanical characters, the photographs, and photomicrographs of wood anatomy are fully up to the excellent standard set in Part I.

THE CARE AND REPAIR OF ORNAMENTAL TREES IN GARDEN, PARK AND STREET. By A. D. C. Le Sueur, B.Sc., F.S.I. Pp. xiv + 257, 8½ × 5½. (London: Country Life, Limited, 1934.) Price 10*s.* 6*d.*

In view of the length of time required by trees to attain maturity, and their value as objects of interest and beauty in the landscape, it is well worth the while of all who own trees, or have them under their care, to understand fully the treatment necessary in order to maintain them in health for as long a period as possible. This treatment can only be intelligently applied when it is based on a knowledge of the structure and physiology of the tree itself. It is with a view to supplying this knowledge, in a form suitable for the practical man, that the author has prepared this book. In this he has been so successful that the work should be in the hands of all who have ornamental trees in their care. It is not so much a work for the forester as for the gardener, and for those officials who have the charge of trees in parks, pleasure grounds, open spaces, streets and roads.

The treatment meted out to trees by the latter is frequently not all it might be, and there is much in the two concluding chapters devoted respectively to the planting and care of street trees, and to road planting, that municipal authorities and other public bodies who are concerned with this subject might peruse with advantage.

A word of approval should be said regarding the illustrations, of which there are forty-two. These have been carefully chosen to explain particular problems or methods of treatment, and the practical man will learn from them, and the concise legends attached to them, more useful information than is often conveyed by lengthy descriptions.

A HAUSA-ENGLISH DICTIONARY AND ENGLISH-HAUSA VOCABULARY. Compiled for the Government of Nigeria by the Rev. G. P. Bargery, with some notes on the Hausa People and their Language by Professor D. Westermann, D.Ph., D.Litt. Pp. liv + 1226, 9 × 6½. (Oxford: The University Press; London: Humphrey Milford, 1934.) Price 25s.

The compiler of this large and important work was formerly attached to the Nigerian Education Department, and is now Lecturer in Hausa at the School of Oriental Studies in the University of London. A dictionary of the size and scope of the present volume, by an officially recognised authority, will be of great value to students of the Hausa language. A large number of the entries are illustrated with idiomatic and other phrases, and the compilation of the work has obviously been carried out with meticulous care and accuracy. The English-Hausa vocabulary, comprising several thousand entries, but occupying only a small portion of the book as a whole, is intended largely for reference purposes in conjunction with the main dictionary and is not presented as a complete English-Hausa dictionary in itself; it nevertheless adds materially to the practical utility of the volume.

An interesting account of the Hausa people and their speech is contributed by Professor Westermann, and Mr. Bargery follows this with an introduction in which he deals in a clear and practical way with the grammar and special characteristics of the language.

AN INTRODUCTION TO THE BIOCHEMISTRY OF NITROGEN CONSERVATION. By Gilbert J. Fowler, D.Sc., F.I.C. Pp. viii + 280, 8½ × 5½. (London: Edward Arnold & Co., 1934.) Price 12*s.* 6*d.*

Nitrogen is one of the chemical elements which are essential to plant and animal life, but in the combined form it has a very marked tendency to revert to the elementary state, in which it is inert and useless as food for animals and many plants. Hence the problem of retaining nitrogen in a combined form which can be utilised directly either by plants or animals assumes considerable importance. In spite of the great advances made in recent years in public hygiene and sanitation generally, the question of the satisfactory conservation of waste nitrogenous organic matter, particularly in tropical countries or in large cities, so as to retain its maximum value for agriculture without detriment to the health or comfort of the population, cannot be said to be solved. The problem is aggravated in a country like India where religious and racial customs come into play.

The author of this book, who has spent many years in scientific work in India, is deeply concerned at the wasteful methods, which prevail in many places, of dealing with nitrogenous materials.

The book opens with a résumé of the general principles of biochemistry and bacteriology as applied to nitrogen conservation, followed by good descriptions of the transformations of nitrogen in nature and their relative importance for human needs. Then follow full accounts of the various methods of sewage disposal, on large and small scales, which are actually in use, the decomposition of nitrogen compounds which they frequently entail being emphasised. The advantages of dealing with this problem by means of the activated sludge or activated compost processes are shown.

A chapter on the cycle followed by sulphur in nature is included, showing its similarity to the transformations of nitrogen.

A number of instances are described in which efficient conservation of nitrogenous compounds is practised, and there is a very useful bibliography of references to textbooks and to original literature, arranged under chapter headings.

UNTERSUCHUNGEN ÜBER DAS KALKBEDÜRFNIS DER BÖDEN DURCH LABORATORIUMS METHODEN UND DÜNGUNGSVERSUCHE. By Professor Dr. O. Lemmermann and Dr. L. Fresenius. Pp. 463, 9½ × 6½. (Berlin: Verlag Chemie, G.m.b.H., 1933.) Price RM. 20.

Since the importance of the acidity or alkalinity of the soil was recognised as a factor affecting the success of agricultural operations, attempts have been made to determine this reaction by laboratory methods capable of giving results which can be interpreted in practical terms in the field. In the case of the vast number of soils whose reaction is more or less acid, and on which lime effects a neutralising or modifying influence, numerous methods have been devised with the object of determining rapidly the degree of acidity or the so-called " lime requirement " of the soil, i.e. the quantity of lime which must be applied in the field in order to render the reaction of the soil approximately neutral. It is, however, well known that not only the actual degree of acidity as measured in terms of hydrogen ion concentration, but also the physical character of the soil profoundly affects the amount of lime required in practice. Also, the optimum reaction of the soil varies for different crops, and is by no means always at or very near the point of neutrality.

The present book gives in considerable detail the results of a co-operative investigation carried out by sixteen German Agricultural Stations over a period of three years (1930–31–32), with the object of finding correlations between a number of laboratory methods for determining lime-requirement and the application of the laboratory results to pot- and field-trials. It was hoped to determine which of the proposed methods is most suitable for the purpose. Owing, however, to the great diversity of the results obtained, due to differences in soil, climate and crops, it was not possible to reach a definite conclusion.

Certain important points were brought out or confirmed. It was shown that of the several forms of lime, there is, on the whole, little difference between the effects of ground limestone and of quicklime, although the quicklime may sometimes produce a more immediate action.

On some types of soil, e.g. light sandy soils with low contents of humus, some of the laboratory methods used gave indications of the correct amount of lime to apply in order to produce the best results with certain crops. In other cases, as with heavy clay soils, the previously known fact that the effect of lime on such soils is not only to reduce the degree of acidity, but also to improve their physical character, was confirmed. With some soils again, none of the laboratory results proved very satisfactory.

The book cannot fail to indicate the extraordinary complexity of the whole question and show the difficulty of correlating to the general requirements of practical agriculture results obtained either in the laboratory or in pot- or field-trials carried out under a definite set of conditions of soil, climate and crop.

A GEOLOGIA DO ARQUIPELAGO DE CABO VERDE. By J. Bacelar Bebiano, G.B.E., A.R.S.M., A.I.M.M. Pp. 275, 9¾ × 7½. (Lisbon: Oficina Grafica, Lda., 1932.)

In 1931 there were published the results of official geodetic and cartographic work in the Cape Verde Island group. During the course of this work, it was decided to incorporate a geological survey of the islands, and in this volume the author has collected the reports made by him during the course of the survey. The field work on the islands of S. Tiago, Maio, Boa Vista and Sal was done in 1926–27, and that on Santo Antão, S. Vicente, S. Luzia and the islets of Branco, Razo, S. Nicolau, Brava and Rombo in 1930–31. The island of Fogo, well known for its great volcano, still remains to be studied in detail. In this work the author has paid particular attention to the relative age of the different volcanic phases, to the genetic relationship between alkaline and normal igneous rocks, and to general tectonics.

The opening chapter refers to previous work in the islands, chiefly by non-Portuguese geologists. Then follows a brief geographical and geological description of the Archipelago as a whole. The greater part of the book is devoted to detailed description of the individual islands, which for this purpose are divided into the Barlavento and Sotavento groups. The treatment of each island consists of a general account of the geology, followed by detailed description of rock types. Useful hydrographical notes, with analyses of river waters, etc., are included for each island.

In a short chapter attention is drawn to beach deposits of magnetite and ilmenite, which are compared with those of Senegal; also to the presence of sulphur, sodium sulphate, (Fogo Island), guano and pumice, and to the therapeutic properties of various waters.

The book is well printed and lavishly illustrated with geological maps, excellent drawings and photographs, and the whole production is a credit to the author and his Portuguese colleagues.

PROSPECTING AND OPERATING SMALL GOLD PLACERS. By William F. Boericke. Pp. xi + 136, 7½ × 5. (New York: John Wiley & Sons, Inc.; London: Chapman & Hall, Ltd., 1933.) Price 9*s.* 6*d.*

This handbook is designed to assist the inexperienced man in prospecting for gold, and thus comes at an opportune time. The author assumes no special knowledge or qualifications other than common-sense and handiness with simple tools, and guides the reader, in clear and practical language, from the finding of the metal to the production stage. An outline of the geology and formation of placers, including eluvial deposits, stream and terrace alluvials, is followed by hints on prospecting. Other chapters then deal with panning and the properties of gold and black sands; the construction of appliances, such as the rocker, Long Tom and sluice-box, etc.; methods of working placer ground; cleaning-up and recovery of gold from black sands; amalgamation; working of dry placers; and several types of concentrating machine. The work concludes with a bibliography, chiefly of American books and articles, and a set of tables.

The subject is dealt with in an extremely practical way, and the book is recommended to small-scale workers and to those trying their hand at prospecting without previous experience.

THE ALLOYS OF IRON AND SILICON. By Earl S Greiner, J. S. Marsh and Bradley Stoughton. Pp. xi + 457, 9 × 6. (New York: McGraw-Hill Book Co., Inc.; London: McGraw-Hill Publishing Co., Ltd., 1933.) Price 30*s.*

The "Alloys of Iron Research" was organised late in 1929, after three years of preliminary work, to review and compile information on iron and its alloys, and a series of monographs embodying the matter collected is to be published. The first of these, on molybdenum, appeared in December 1932; the second volume deals with silicon, while a third on tungsten is in active preparation.

Alloys of iron and silicon play an important part in every-day life. Thus, it has been estimated that from 1907 to 1930 their use in the electrical industry effected a total saving of some £290,000,000, due primarily to the inventions of Sir Robert Hadfield, a pioneer in this field. It is fitting, therefore, that the knowledge on these alloys should be made readily available to those interested and this book is a good effort in this direction. Although most investigations on the subject have taken place during the last fifty years, the literature is so voluminous that in the compilation of the present volume no fewer than 1,200 articles, in many languages, were examined, exclusive of patent literature. Further evidence of the extent of the compilation is given by the selected bibliography in which there are 475 numbered references, arranged chronologically, beginning with Berzelius, 1808.

In this book, which is a valuable and up-to-date work of reference, the subject-matter is presented in a clear and intelligible style, not over-burdened with facts, and information on any aspect of the subject is easy to find.

The book is written in a critical vein, which is helpful in giving the reader a considered opinion on the present situation with regard to each problem. Where the information available on any point is inadequate, this is mentioned in the summary at the end of each chapter, while the last chapter, entitled a general summary, contains further brief notes on the substance of the book. These small extra services make the work invaluable to students and research workers, and it should certainly be in the libraries of all those who are technically interested in the iron and steel industry.

STANDARD METHODS OF ANALYSIS OF IRON, STEEL AND FERRO-ALLOYS. Pp. 35, 9 × 6. (Sheffield: The United Steel Companies, Ltd., 1933.) Price 4*s.* 6*d.*

The United Steel Companies, Limited, who incorporate ten important firms in this country, realised the need for standardising the methods of analysis employed by their various laboratories and appointed a committee of chemists and metallurgists to examine the methods available. The procedures recommended by the committee have been adopted with success in all these laboratories, and were thought to be of sufficient interest to warrant publication.

Most of the methods recommended are well known, but a few recent introductions, such as the colorimetric estimation of chromium with diphenylcarbazide and the precipitation of arsenic with hypophosphite, are included. In view of this it is surprising that the determination of aluminium as phosphate is recommended in the analysis of aluminium-silicon alloy. Previous investigators have shown that this method, which is still employed by steelworks chemists, is liable to introduce errors in the determination of aluminium when this element is a major constituent. The oxyquinoline method is more accurate for this purpose, but unfortunately, the expense of the reagent appears to militate against its wider use.

Where practicable, volumetric methods have been included in this book. These are very suitable for routine work, but for single determinations gravimetric methods are often more accurate and equally rapid. Thus in the recommended procedure for nickel, the dimethylglyoxime precipitate is dissolved and the solution titrated, using the cyanide method. Weighing the dimethylglyoxime precipitate direct is a useful alternative which might have been indicated.

The instructions given are brief and mainly in note form, but they are inclined to be a little inadequate at times. The instruction on page eight to " bake gently on the cool side of a hot plate " is a case in point. Hot plates vary in size and thickness, and in the method of heating, and some idea of the actual temperature required would have been more useful.

The book is well produced, of convenient size, interleaved with ruled paper for additional notes by the reader, and should prove of value to steel-works chemists, for whom it is primarily intended. A knowledge of the analytical methods in use in the large industrial laboratories is of the greatest interest to chemists generally, and the United Steel Companies, Limited, are to be congratulated on the publication of this book. It is to be hoped that their example will be followed by other firms engaged in the chemical and metallurgical industries.

LES RESSOURCES MINÉRALES DE LA FRANCE D'OUTRE-MER. I. LE CHARBON. Pp. 245, 9¾ × 6½. (Paris : Société d'Edition Géographiques, Maritimes et Coloniales, 1933.)

The first publication of the newly formed Bureau d'Etudes géologiques et minières coloniales was noticed in this BULLETIN (1932, **30**, 528). This very active body has now commenced the publication of a series of volumes on the mineral resources of the French colonies, the first of which is devoted to the subject of coal.

Several other volumes are in course of preparation, each devoted to a separate mineral or group of minerals, and all will follow, so far as possible, a common plan. The deposits in each of the French colonies will be described by an expert with special knowledge of the country.

As regards coal, there are three actual centres of production, Algeria, Morocco and Indo-China, while in Madagascar and New Caledonia there are beds which are not at present exploited. The principal producer is Indo-China, where the annual output is approximately

2,000,000 tons, consisting mainly of anthracite, while Algeria and Morocco contribute some 20,000 tons each of bituminous coal and anthracite respectively. France is, however, the world's chief importer of coal, and her colonies do not contribute more than an insignificant fraction of her own needs, for the geographical situation of Indo-China renders it necessary for that colony to trade with China and Japan rather than with the mother country.

The descriptions of deposits in North Africa, which occupy 45 pages of the book, have been written by L. Clariond, who points out that comparatively little is yet known as to the potential coal resources of the area, except in Morocco, where at Djerada the reserves of anthracite exceed 10,000,000 tons. In Algeria, the bituminous coal exploited on the fringe of the Sahara at Kenadzu occurs in numerous thin seams, none exceeding 18 inches in thickness. There are two pits capable of producing about 100 tons a day and a third is being sunk, but the output is limited to the needs of the local State railways. One notices in this section an almost complete absence of analyses which might assist the reader to assess the quality of the various coals under discussion.

The section on Madagascar, written by F. Blondel, occupies 35 pages. The principal coal area extends for about 20 miles from Ambohibato to Antararatsy, but most of the prospecting work has been carried out in the basin of the Sakoa, where five seams have been noted which give a mean workable thickness of about 12 yards. Development work indicates that some 350,000,000 tons are available in this region down to about 1,600 feet, and analysis shows that the product is a fairly good steam coal. Owing to the economic depression the question of commercial development is at present in abeyance, but the author concludes the section with a statistical examination of the marketing problem. An exhaustive bibliography is appended.

With the exception of six pages on New Caledonia, the whole of the remainder of the volume is devoted to Indo-China, again from the pen of F. Blondel. The principal deposits are the anthracites of Quang-yen which extend for 100 miles in the form of an arc of a circle, from the island of Kébao to the Seven Pagodas. They have been worked for many years and include the Hongay concessions which have produced nearly 1,500,000 tons in a year. The Phan-mé coalfield, which occupies a position farther west, achieved its maximum production of 37,000 tons in 1930. The bituminous coals of Phu-nho-quan, Ninh-binh and Van-yen occupy an area of great geological complexity and have not been extensively developed as yet. Farther south are the coalfields of Nong-son and Tourane, which have been worked for some years in a small way. A new field has recently been found to the east of Saravane, but its extent has not yet been investigated. Indo-China also possesses numerous beds of lignite which have been worked in several areas, notably in the vicinity of Tuyen-quang. The chapters on Indo-China conclude with a detailed discussion of the coal situation of the Far East which contains much useful information.

The publication as a whole is a most valuable compilation on a subject about which the available literature is widely scattered and difficult of access. It has been skilfully prepared and is replete with geological sketch-maps to guide the reader, in addition to exhaustive bibliographies for each section. The Bureau responsible for the publication of this new series of memoirs is to be congratulated upon its initial effort.

BOOKS RECEIVED FOR NOTICE

THE 1820 SETTLERS IN SOUTH AFRICA: A Study in British Colonial Policy. By Isobel Eirlys Edwards, M.A. Royal Empire Society, Imperial Studies, No. 9. Pp. 207, 8¾ × 5¾. (London, New York, Toronto: Longmans, Green & Co., 1934.) Price 7*s.* 6*d.*

SOIL ANALYSIS: A HANDBOOK OF PHYSICAL AND CHEMICAL METHODS. By C. Harold Wright, M.A., F.I.C. Pp. viii + 236, 8½ × 5½. (London: Thomas Murby & Co.; New York: D. Van Nostrand Co., Inc., 1934.) Price 12*s.* 6*d.*

SUPPRESSION OF WEEDS BY FERTILIZERS AND CHEMICALS. By H. C. Long, B.Sc. (Agric.). Pp. 57, 8½ × 5½. (Obtainable from the Author, "The Birkins," Orchard Road, Hook, Surbiton, Surrey.) Price 2*s.* net.

THE CULTURE AND MARKETING OF TEA. By C. R. Harler, Ph.D., B.Sc., F.I.C., F.R.Met.Soc. Pp. xi + 389, 8½ × 5½. (London, New York, Bombay, Calcutta, Madras: Humphrey Milford, Oxford University Press, 1934.) Price 12*s.* 6*d.*

THE TOXICOLOGY OF PLANTS IN SOUTH AFRICA, together with a Consideration of Poisonous Foodstuffs and Fungi. By Douw G. Steyn, B.Sc., Dr.Med.Vet., D.V.Sc. South African Agricultural Series—Volume XIII. Pp. xii + 631, 9 × 6. (South Africa: Central News Agency, Ltd.; London: Gordon & Gotch, 1934.) Price 47*s.* 6*d.*

A MANUAL OF THE TIMBERS OF THE WORLD: THEIR CHARACTERISTICS AND USES. By Alexander L. Howard. Revised Edition. Pp. xxiii + 627, 8¾ × 5¾. (London: Macmillan & Co., Ltd., 1934.) Price 36*s.*

THE EXPERIMENTAL PRODUCTION AND THE DIAGNOSIS OF FROST INJURY ON FOREST TREES. By W. R. Day, B.Sc., M.A., and T. R. Peace, M.A. Oxford Forestry Memoirs, Number 16, 1934. Pp. 60, 10¾ × 7½. (Oxford: The Clarendon Press, 1934.) Price 6*s.*

LA MORIA DEGLI OLMI E LA DIFFUSIONE IN ITALIA DELL' OLMO SIBERIANO (*Ulmus pumila* L.). By Arturo Ansaloni. Pp. 119, 10 × 7. (Bologna: Edizioni Selva, 1934.)

LES RESSOURCES MINÉRALES DE LA FRANCE D'OUTRE-MER. II. Le Fer, le Manganèse, le Chrome, le Nickel, l'Etain, le Tungstène, le Graphite, le Glucinium, le Molybdène, le Cobalt, le Titane, le Vanadium. Pp. 436, 9¾ × 6¼. (Paris: Société d'Editions Géographiques, Maritimes et Coloniales, 1934.)

MODERN ROAD EMULSIONS. A Treatise based on a Series of Lectures by Members of the Road Emulsion and Bituminous Roads Association, Ltd. Edited by F. H. Garner, M.Sc., Ph.D., F.I.C., in collaboration with L. G. Gabriel, B.Sc., M.Inst.P.T., and H. J. Prentice. Pp. 222, 8½ × 5½. (London: The Carriers Publishing Co., Ltd., 1933.) Price 12*s.* 6*d.*

REPORTS OF RECENT INVESTIGATIONS AT THE IMPERIAL INSTITUTE

Selected from the Reports made to the Dominion, Colonial and Indian Governments

ESSENTIAL OILS FROM EAST AFRICA

OWING to the general world depression and the consequent fall in prices of staple commodities, growers of such crops as coffee and maize in East Africa have been seriously affected, and many of them have turned their attention to secondary crops which give a quick and high return. Amongst these, essential oil plants have taken a prominent place. There has been insufficient time yet for any extensive industry to grow up, but already Kenya geranium oil is well known on the market and others will doubtless make their appearance in due course. Kenya cedar-wood oil, which falls into a somewhat different category, being a by-product of the local timber industry, is also well known (see this BULLETIN, 1931, **29**, 430, for an account of the examination of this oil).

The Imperial Institute has been closely associated with this new industry from its commencement, and a large number of samples of oils of different kinds, prepared by planters or by the local Agricultural Departments, have been received for examination. Most of the samples represent oils familiar to the market, but in addition a number of new oils, distilled from indigenous plants, have been examined in order to determine their commercial possibilities. The results of the investigation of the principal samples of these oils from East Africa are given in the following pages.

Reference should also be made to the paper by Dr. R. R. Le G. Worsley on " Some East African Essential Oils," published on pages 253–270 of this issue.

GERANIUM OIL FROM KENYA

The samples of geranium oil received from Kenya include oils distilled from varieties of Pelargonium which have existed for some time in the country, and also from varieties recently introduced. The former category include two forms, known locally as "Nyeta" and "Mahwa" (or "Mawah") respectively, whilst the introduced kinds include varieties of *Pelargonium radula* (*rosea*) from South Africa and the Royal Botanic Gardens, Kew. The species of Pelargonium from which the " Nyeta " oil was obtained does not appear to have been determined, but specimens of the plants from which " Mahwa " oil is produced were sent to the Imperial Institute some time ago and were identified at Kew as *P. graveolens* Ait.

(1) *" Nyeta " Geranium Oil.*—Two samples of oil were received from a planter in September 1929. They consisted of clear, very pale greenish-yellow oils, which possessed the characteristic odour of geraniol but also had a distinct odour of citronellol. No. 1 was stated to have been distilled " slowly, according to the books " and No. 2 " quickly, under increased pressure."

The oils were found to have the following constants, which are shown in comparison with those recorded by Parry (*The Chemistry of Essential Oils*, 1918, Vol. I, pp. 467–468) for commercial Algerian and Bourbon geranium oils :

—	Present samples.		Commercial geranium oils.	
	(1).	(2)	Algerian.	Bourbon
Specific gravity at 15·5/15·5° C . . .	0·872	0·873	0·892 to 0·904	0·888 to 0·8965
Optical rotation α_D . .	− 0·06°	+ 0·09°	− 7° to − 11·5°	− 8° to − 14°
Refractive index n_D 20° C .	1·4615	1·4615	1·465 to 1·472	1·462 to 1·4677
Acid value . . .	1·9	2·0	1·5 to 10	1·5 to 10
Ester value . . .	17·1	16·6	40 to 70 (rarely as low as 36)	50 to 78 (rarely below 55)
Esters, as geranyl tiglate *per cent*	7·2	7·0	—	—
Ester value after acetylation	242·2	243·7	200 to 230	205 to 230
Total alcohols (as $C_{10}H_{18}O$) *per cent*	81·4	82·0	—	—
Solubility in 70 per cent. alcohol at 15° C . .	Soluble in 2·5 vols.	Soluble in 2·5 vols.	Soluble in 2·5 to 3 vols.	Soluble in 2·5 to 3 vols.

From these results it will be seen that the constants of the two oils from Kenya were practically identical, and differed widely from those of the Algerian and Bourbon oils with which they are compared in the above table.

The oils were submitted to (*a*) soap manufacturers and (*b*) essential oil distillers, who furnished the following observations on their quality and value :

(*a*) " We have examined the samples of geranium oil forwarded with your letter of the 22nd ult. and have come to the conclusion that No. 2 is the better and nearer to the geranium oil from Bourbon. We do not consider that these oils have the ' rosy ' odour of geranium at first, but as the lighter constituents evaporate the ' rosy ' odour develops. We think that these oils contain a much larger proportion of citronellol than either Algerian or Bourbon geranium oil, and should value them at about 9*s*. per lb. each."

(*b*) " These oils are distinctly different to other geranium oils from Kenya Colony which we have hitherto examined, and for our own manufacturing purposes we cannot foresee that the oils could be put to good use. We should consider the market values to be below those obtained for the oils being exported from Kenya Colony as ' Mawah ' oil."

At the date of the above reports (January 1930) Algerian and Bourbon geranium oils were quoted in London at 18*s*. to 19*s*. and 16*s*. to 17*s*. 6*d*. per lb. respectively.

The results of examination show that these oils from the Nyeta variety of geranium differ considerably, both in constants and odour, from the commercial geranium oils imported from Algeria and Bourbon (Réunion). The odour appears to be reduced in intensity by the presence of a large percentage of citronellol, which renders the oil less valuable for direct use in perfumery, and as a source of geraniol. It would therefore seem desirable to devote attention to the cultivation of varieties of geranium which yield oils containing higher proportions of geraniol.

(2) *" Mawah " Geranium Oil.*—This sample was also received from a planter in 1929. It was stated that the

sample was obtained from a first cutting of the plants, and represented oil which was being distilled on a commercial scale for use in soap-making.

The sample consisted of a clear, brownish-yellow oil, having the characteristic odour of geranium oil. It was examined with the following results, which are shown in comparison with those recorded for the Algerian and Bourbon geranium oils of commerce :

—	Present sample	Commercial geranium oils	
		Algerian	Bourbon
Specific gravity at 15·5/15·5° C . . .	0·892	0·892 to 0·904	0·888 to 0·8965
Optical rotation α_D . .	− 18·47°	− 7° to − 11·5°	− 8° to − 14°
Refractive index n_D 20° C .	1·470	1·465 to 1·472	1·462 to 1·4677
Acid value . . .	5·8	1·5 to 10	1·5 to 10
Ester value . . .	22·0	40 to 70 (rarely as low as 36)	50 to 78 (rarely below 55)
Esters, as geranyl tiglate *per cent*	9·3	—	—
Ester value after acetylation	205·8	200 to 230	205 to 230
Total alcohols (as $C_{10}H_{18}O$) *per cent*	66·9	—	—
Solubility in 70 per cent alcohol at 15° C. . .	Soluble in 1·8 vols	Soluble in 2·5 to 3 vols	Soluble in 2·5 to 3 vols

From these results it will be seen that the present oil, though of good quality, differs from Algerian and Bourbon geranium oils in having a low ester value. It also had a less strong and less pleasant odour.

(3) *Pelargonium radula* (*rosea*).—Two samples of oil distilled from plants representing two types of Pelargonium recently introduced into Kenya, from South Africa and the Royal Botanic Gardens, Kew, respectively, and stated to be varieties of *P. radula* (*rosea*), were received from the Senior Agricultural Chemist in June 1933. They were as follows :

" *Variety S.A.*"—This was a clear oil of very pale brownish-yellow colour. The odour was superior to that of " Mawah " geranium oil and more resembled that of commercial Algerian and Bourbon oils, though somewhat weaker. A slight subsidiary odour, recalling that of verbena, was observed.

" *Variety Q* (*Kew*)."—This oil was of the same colour as the foregoing sample, but possessed a slightly superior odour, which was less sharp, very pleasant and rose-like, and free from the subsidiary odour.

The samples were found to have the following constants, which are shown in comparison with the corresponding figures obtained for samples of " Mawah " and " Nyeta " geranium oils previously received at the Imperial Institute and with the recorded figures for commercial Algerian and Bourbon oils :

—	Present samples.		Samples received from Kenya in 1929.		Commercial geranium oils.	
	"S.A."	"Q."	Mawah.	Nyeta.	Algerian.	Bourbon.
Specific gravity at 15·5/15·5° C.	0·9055	0·9008	0·892	0·873	0·892 to 0·904	0·888 to 0·8965
Optical rotation α_D	− 9·17° at 23° C.	− 9·28° at 23° C.	−18·47°	+ 0·09°	− 7° to − 11·5°	− 8° to − 14°
Refractive index n_D 20° C.	1·4721	1·4705	1·470	1·4615	1·4650 to 1·4720	1·4620 to 1·4677
Acid value	7·3	6·3	5·8	2·0	1·5 to 10	1·5 to 10
Ester value	71·8	63·4	22·0	16·6	40 to 70 (rarely as low as 36)	50 to 78 (rarely below 55)
Esters, expressed as geranyl tiglate *per cent.*	30·3	26·7	9·3	7·0	—	—
Solubility in 70 per cent. alcohol at 15·5° C.	Soluble in 2·1 vols.	Soluble in 2·2 vols.	Soluble in 1·8 vols.	Soluble in 2·5 vols.	Soluble in 2·5 to 3·0 vols.	

From these results it will be seen that the constants of the present samples differ considerably from those of the " Mawah " and " Nyeta " oils examined at the Imperial Institute in 1929, but are very similar to those of the ordinary geranium oils of commerce. The constants of both oils fall within the range of figures recorded for Algerian oil, except as regards the specific gravity and ester value of the " S.A." sample which are slightly in excess of the recorded maxima.

The oils were submitted to a firm of essential oil distillers in London, who furnished the following observations :

" The odour values of these samples show a very marked improvement on those of any oils we have ever examined from Kenya, and are very much superior to Mawah geranium oil. The samples compare very favourably with standard types of commercial geranium oil and in fact, in our opinion, they are equal to many parcels of Bourbon and African oils offered on the market. There is very little to choose between the two types submitted, and either, or a bulk of the two, would be quite suitable for commercial use."

Consignments of oil of the quality of the present samples, either separate or mixed, should be marketable in the United Kingdom in competition with the ordinary geranium oils of commerce.

(4) *Pelargonium radula and other forms.*—Five further samples of oil, distilled from varieties of Pelargonium plants experimentally grown by the Agricultural Department, were received from the Senior Agricultural Chemist in October 1933. They consisted of oils obtained by the distillation of further cuttings of the two varieties previously dealt with (" S.A." and " Q."), together with oils obtained from three other kinds, designated 1, 2 and 3. The Agricultural Chemist thinks that varieties 2 and 3 may be identical with " Q," although one of them is rather stronger growing. Variety 1 is probably another species of Pelargonium, its habit of growth and lack of flowers being unlike both the strains of *P. radula.*

All the samples except No. 1 consisted of clear, pale yellowish-green oil ; No. 1 was pale yellowish-brown.

A few needle-shaped crystals had separated from Sample Q, but no further separation was effected by cooling the oil. The crystalline substance was non-acidic in character, and apparently odourless ; it seemed probable that it was a hydrocarbon, but further examination was not possible with the minute quantity available.

The odour of Sample Q was rather more rose-like than that of Sample S.A. when first tested, but after exposure for a short time the difference between the odours of these two oils was scarcely noticeable. There was also very little difference in odour between the three oils Q, 2 and 3, though 2 and 3 were possibly very slightly superior to Q. On the other hand, the odour of No. 1 was distinct from those of all the other oils, being cruder and much less pleasant.

On comparing the present S.A. and Q oils with the previous samples of these varieties examined at the Imperial Institute, it was noted that the earlier samples had somewhat improved on keeping and possessed a rather more pronounced rose-like odour than when first received.

In the following table the physical constants of the five present samples are compared with those of the previous samples of S.A. and Q oil, and with the figures recorded for commercial Algerian and Bourbon oils :

—	Specific Gravity at 15·5/15·5° C.	Optical Rotation α_D	Refractive Index n_D 20° C.
Present samples :			
S A	0·9001	− 13·19° at 18° C	1·4695
Q	0·9014	− 12·8° at 17·5° C	1·4700
1	0·8949	− 10·0° at 17·5° C.	1·4724
2	0·9009	− 14·17° at 17·8° C	1·4700
3	0·8993	− 12·99° at 20·2° C.	1·4697
Previous samples.			
S A.	0·9055	− 9·17° at 23° C.	1·4721
Q	0·9008	− 9·28° at 23° C.	1·4705
Commercial oils :			
Algerian	0·892 to 0·904	− 7° to − 11·5°	1·4650 to 1·4720
Bourbon	0·888 to 0·8965	− 8° to − 14°	1·4620 to 1·4677

From these results it will be seen that in respect of the constants determined, the five present oils showed no marked differences, and were also similar to the two earlier samples, except as regards the optical rotation. The present sample No. 1 had the lowest specific gravity of all the seven oils.

The five oils now under report were submitted to (*a*) essential oil distillers and (*b*) importers in London, who furnished the following observations :

(*a*) " We have compared these oils with Bourbon and African stock, and agree that the sample marked No. 1 is of low odour value. With reference to the other samples, we prefer those marked 2, 3 and S.A., putting S.A. first and Q last. They all compare reasonably well with the standard qualities of African and Bourbon oils and could replace them for most purposes."

(*b*) " We have carefully examined the samples, and confirm the view that No. 1 is of little commercial value and that there is little to choose between S.A., Q, 2 and 3. In our opinion, these four oils are all of good quality and marketable."

GERANIUM OIL FROM TANGANYIKA TERRITORY

Two samples of geranium oil were forwarded to the Imperial Institute by the Director of the East African Agricultural Research Station, Amani, in March 1932; a memorandum by the Biochemist regarding the origin and mode of distillation of the oils accompanied the samples.

The samples were stated to have been obtained by steam distillation from the leaves of two different types of *Pelargonium capitatum* plants, picked in the early morning and distilled at once. It was desired to ascertain whether the quality of either oil indicated that the type of plant yielding it would be worth distributing to growers.

The samples were as follows:

A. From the leaves of P. capitatum (yield, 0·21 *per cent.).* A clear, pale greenish-yellow oil.

B. From a variety of P. capitatum with a much finer leaf (yield, 0·26 *per cent.).* A clear, pale brownish-yellow oil.

Both oils were inferior in odour to the Algerian and Bourbon (Réunion) geranium oils of commerce.

The oils were examined with the following results, which are shown in comparison with those recorded for commercial Algerian and Bourbon geranium oils:

—	Present samples		Commercial geranium oils	
—	A	B	Algerian	Bourbon
Specific gravity at 15·5/15·5° C	0·8948	0·8880	0·892 to 0·904	0·888 to 0·8965
Optical rotation α_D	− 8·95° at 19° C.	− 30·73° at 21° C	− 7° to − 11·5°	− 8° to − 14°
Refractive index n_D 20° C	1·4705	1·4578	1·4650 to 1·4720	1·4620 to 1·4677
Acid value	15·2	7·9	1·5 to 10	1·5 to 10
Ester value	13·2	12·4	40 to 70 (rarely as low as 36)	50 to 78 (rarely below 55)
Esters (expressed as geranyl tiglate) . . *per cent*	5·6	5·2	—	—
Solubility in 70 per cent alcohol at 15·5° C.	Soluble in 1·8 vols.	Soluble in 1·9 vols.	Soluble in 2·5 to 3 vols.	

Owing to the small quantity of oil received in each case, it was not possible to determine the amount of total alcohols present in these oils. It will be seen, however, from the results of examination that both oils contain a considerably smaller amount of esters than commercial Algerian and Bourbon oils, and that Sample B also differed appreciably from the commercial oils in optical rotation and refractive index.

The oils were submitted to (*a*) a firm of essential oil distillers, and (*b*) soap manufacturers, who reported on them as follows:

(*a*) " Sample A is mainly geraniol, with a small amount of citronellol. The oil has a soft, sweet odour somewhat of the nature of linalool and cananga oil, and in our opinion it is not a satisfactory substitute for Bourbon or African geranium oils. Sample B has a coarse odour somewhat resembling menthol, and would not satisfactorily substitute Bourbon or Algerian oils.

" We should not anticipate a great demand for either of these oils."

(*b*) The perfumery expert of the soap manufacturers also stated that the oils were unlike either Algerian or Bourbon oil, and that it was not possible to assign a definite value to them. He expressed the view that the plants from which Sample B was distilled were of an undesirable type and should not be cultivated.

The examination has shown that neither of these samples compares favourably with the geranium oils of commerce, but that Sample A, derived from *P. capitatum*, is of better quality than Sample B, obtained from a variety of the same species with much finer leaves.

Dr. Worsley deals further with these Pelargonium oils in his paper (see p. 265) and gives the results of examination of the oil obtained from *P. capitatum* after keeping the leaves for 24 hours.

GERANIUM OIL FROM UGANDA

Two samples of oil obtained from a species of Pelargonium, which had been identified at Kew as *P. radula*, were received from the Director of Agriculture in July 1931, and August 1932, respectively.

No. 1.—This sample consisted of a pale yellow, mobile oil. It was examined with the following results, which are shown in comparison with the corresponding figures recorded for commercial Algerian and Bourbon geranium oils :

—	Present sample	Recorded figures for commercial oils	
		Algerian	Bourbon.
Specific gravity at 15·5/15·5° C .	0·8956	0·892 to 0·904	0·888 to 0·896
Optical rotation α_D	−16·29° at 18° C	−7° to −11·5°	−8° to −14°
Refractive index n_D 20° C . .	1·4719	1·465 to 1·472	1·462 to 1·4677

The oil possessed an odour which was decidedly pleasant, but lacked the more pronounced geraniol odour of the commercial oils. It will be observed that its optical rotation is outside the range recorded for the latter oils, and in this respect it more resembles the sample of Mawah geranium oil from Kenya examined at the Imperial Institute, which had an optical rotation of −18·47° (see p. 197). The physical constants of a geranium oil, however, afford little indication of its commercial value.

The oil was submitted to a firm of essential oil distillers in London, who described it as distinctly different in character from the usual Bourbon or African oils as it apparently contains citronellal and iso-pulegol as well as geraniol and citronellol. In their opinion the oil is not likely to command so high a price as the true geranium oils.

No. 2.—This sample was pale yellow and slightly turbid owing to the presence of water. By filtration through paper the oil was rendered clear.

The oil was examined with the following results, which are shown in comparison with those obtained for the previous sample from Uganda, and with the corresponding figures recorded for commercial Algerian and Bourbon geranium oils :

—	*P. radula.*		Recorded figures for commercial oils.	
	Present sample.	Previous sample from Uganda.	Algerian.	Bourbon.
Specific gravity at 15·5/15·5° C.	0·8941	0·8956	0·892 to 0·904	0·888 to 0·896
Optical rotation α_D	− 15·83 at 22° C	− 16·29 at 18° C.	− 7° to − 11·5°	− 8° to − 14°
Refractive index n_D 20° C.	1·4718	1·4719	1·465 to 1·472	1·462 to 1·4677
Acid value	8·7	—	1·5 to 10	1·5 to 10
Ester value	22·5	—	40 to 70	50 to 78
Esters (expressed as geranyl tiglate) . *per cent*	9·5	—	—	—
Ester value after acetylation	214·2	—	200 to 230	205 to 230
equivalent to total alcohols (expressed as geraniol) . *per cent*	70·2	—	—	—
Solubility in 70 per cent alcohol	Soluble in 1·9 vols	—	Soluble in 2·5 to 3 vols.	Soluble in 2·5 to 3 vols.

It will be seen from these figures that the physical constants of the present sample agree closely with those of the oil previously examined. The oil was more strongly lævo-rotatory and contained a lower percentage of esters than normal Algerian and Bourbon geranium oils. The proportion of total alcohols was, however, fairly good.

The odour of the sample lacked the intense rose-like character of the Algerian and Bourbon oils, and was not so pleasant as that of the previous sample from Uganda. There was an objectionable subsidiary odour, due probably to the presence of sulphur compounds, traces of which are also present in the French oils. It was found that partial oxidation of the oil by shaking it with a solution of hydrogen peroxide considerably improved its odour.

The oil was submitted to three firms of importers and two firms of essential oil distillers, who furnished the following reports :

Importers

(*a*) " We think that there would be a demand for this grade of oil, and we ourselves are prepared to take a small quantity for trial purposes, if it could be arranged. As regards the price, of course the market fluctuates from time to time, but we should think the value would be somewhere about 8*s.* to 9*s.* per lb. in London."

(*b*) " We do not like the odour, and think that on this account alone it would be almost impossible to interest buyers. The physical constants as shown by your analysis are unlike either of the geranium oils of commerce. The specific gravity and refractive index are both high, and the optical rotation and ester value are very low. In these circumstances we cannot recommend any attempt to produce this oil on a commercial scale, for we are confident that it would be extremely difficult to find a market for it. For this reason we shall not attempt to place any value on it. If Uganda wishes to produce successfully a commercial geranium oil they will have to concentrate on the production of an oil which will compete with either the Bourbon or the Algerian oils, which are the only important geranium oils in the market. If we may make a suggestion, we think that the Department of Agriculture in Uganda would get better results from *Pelargonium graveolens.*"

(*c*) " We consider that this oil has some possibilities. Although it does not possess the intense odour of the Bourbon oil, we consider it to be greatly superior to the geranium oil distilled in Kenya (sometimes described as Mawah oil), and if it could be produced to sell at about 10*s.* per lb. we think it might have possibilities."

Essential Oil Distillers

(*a*) " Our laboratory report that the odour of the raw oil is very poor indeed, but after saponification a sweet-smelling product is obtained. They add that the oil would not serve as a substitute for Bourbon geranium, but can be used as a source of rhodinol (geraniol), which, however, would have to be offered as a different grade from the rhodinol obtained from Bourbon geranium oil."

(*b*) " The oil has a coarse woody note, and could not replace Bourbon or Algerian oils on the market for use in compounding perfumed oils or for perfuming of soap."

This geranium oil from Uganda is much inferior to the Algerian and Bourbon oils, and is more comparable in value with the " Mawah " geranium oil produced in Kenya.

The latter oil only finds a limited market in the United Kingdom and is chiefly exported to the United States. It is possible that geranium oil represented by this sample from Uganda might find a similar outlet, but the value suggested (8*s.* to 10*s.* per lb.) is much less than that of the Algerian and Bourbon oils, which were then quoted at about 23*s.* per lb. (spot) in London (December 1932).

PEPPERMINT OIL FROM KENYA

Three reports on peppermint oil have been furnished to the authorities in Kenya during the last two years.

Report No. 1.—A sample of oil which had been distilled from black peppermint plants, grown by a planter at Ngong from runners obtained in England and supplied to him by the Agricultural Department, was forwarded to the Imperial Institute by the Acting Senior Agricultural Chemist in February 1932.

The sample consisted of clear, yellowish-brown peppermint oil, of good odour and taste.

The oil was examined with the following results, which are shown in comparison with the ranges of corresponding figures recorded for English and American peppermint oils:

—	Present sample	English peppermint oil	American peppermint oil.
Specific gravity at 15·5/15·5° C.	0·9219	0·900 to 0·912	0·899 to 0·915
Optical rotation α_D	− 25·38° at 19° C.	− 23° to − 33°	− 20° to − 35°
Refractive index, n_D 20° C.	1·4606	1·4600 to 1·4640	1·4600 to 1·4635
Acid value	1·5	—	—
Ester value	75·1	—	—
equivalent to esters (as menthyl acetate) . *per cent*	26·6	3 to 21	5 to 9
Ester value after acetylation	200·6	—	—
equivalent to total acetylisable constituents (as menthol) *per cent*	65·8	50 to 68	48 to 63
Solubility in 70 per cent. alcohol at 15·5° C.	Soluble in 3·9 vols.	Soluble in 3 to 4 vols.	Soluble in 3 to 5 vols., sometimes with opalescence

These results show that this oil, obtained from peppermint plants of English origin, gave higher figures for specific gravity and the amount of esters present than those recorded for normal English peppermint oils.

The oil was submitted to (*a*) importers and (*b*) essential oil distillers in London, who furnished the following observations :

(*a*) " We find the odour of this oil to be good, and with its high menthol content, as compared with the American oil, we should consider its value to be in the neighbourhood of 11*s*. per lb."

(*b*) " We have examined this with considerable interest. The quality is not by any means the same as that from herb grown in this country, but in our opinion it has quite a nice aroma and provided continuity of supplies and regularity in quality can be guaranteed we think there might be some business to be done in the oil ; but we have had so many different types of peppermint oil, so-called Italo-Mitcham and Franco-Mitcham, that have varied in quality, that buyers are a little bit chary of taking up any fresh type of oil. Manufacturers naturally wish to keep their quality uniform.

" We give below notes from our laboratory :

" The odour of this sample is very pleasant and flowery, but quite different from English oil, which is much more pungent. This we imagine may be accounted for by the extraordinary ester percentage of 26·6 per cent., which we have never before met in any peppermint oil. Further, we note that the specific gravity, 0·9219, is high. The other figures found at the Imperial Institute appear to be normal."

The results obtained with the present sample showed that it differed somewhat from normal English peppermint oil, and in order to ascertain whether the quality remains constant or whether it improves or deteriorates on continued cultivation of the plants, it was suggested that further samples might be distilled in due course and forwarded to the Imperial Institute for examination and valuation.

Report No. 2.—In accordance with the suggestion contained in the previous report, a sample of oil obtained

—	Present samples			Previous sample from Ngong.	English peppermint oil.	American peppermint oil.
	Ngong.	Kipipiri.	Molo.			
Specific gravity at 15·5/15·5° C.	0·9282	0·9415	0·9089	0·9219	0·900 to 0·912	0·899 to 0·915
Optical rotation α_D . . .	−12·16° at 23° C.	− 24·53° at 23° C.	−36·36° at 23° C.	−25·38° at 19° C.	− 23° to − 33°	− 20° to − 35°
Refractive index n_D 20° C. .	1·4642	1·4627	1·4606	1·4606	1·4600 to 1·4640	1·4600 to 1·4635
Acid value	2·1	5·0	0·3	1·5	—	—
Ester value	72·6	147·4	47·2	75·1	—	—
equivalent to esters (expressed as menthyl acetate) . . *per cent.*	25·7	52·1	16·7	26·6	3 to 21	5 to 9
Ester value after acetylation .	192·8	239·2	228·9	200·6	—	—
equivalent to total acetylisable constituents (expressed as menthol) *per cent.*	62·8	81·2	77·0	65·8	50 to 68	48 to 63
Menthone (by the hydroxylamine method) . *per cent.*	14·9	16·1	8·4	—	8 to 12[1]	9 to 16[1]
Solubility in 70 per cent. alcohol at 15·5° C.	Soluble in 9·0 vols. with turbidity.	Soluble in 5·2 vols.	Soluble in 3·3 vols.	Soluble in 3·9 vols.	Soluble in 3 to 4 vols.	Soluble in 3 to 5 vols., sometimes with opalescence.

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[1] *Method of determination not stated.*

from a second cutting at Ngong was forwarded by the Senior Agricultural Chemist in June 1933. Two other samples of peppermint oil were received at the same time, one representing the results of the experimental distillation in the Agricultural Department of peppermint plants from Kipipiri, whilst the third sample represented a bulk distillation of a crop grown by a planter at Molo, at an altitude of 9,300 ft.

The samples from Ngong (second cut) and Kipipiri (first cut), consisted of clear, pale brownish-yellow oils; that from Molo was very pale straw-yellow in colour.

The three oils were found to have the constants which are shown on page 209 in comparison with those obtained for the sample of peppermint oil from Ngong (first cut), and with the recorded figures for English and American peppermint oils.

It will be seen that, apart from the low optical rotation and poor solubility, the constants of the present sample from Ngong are very similar to those of the previous oil from the same source, the figures in both cases differing to some extent from those recorded for commercial peppermint oils.

The constants of the Kipipiri oil are also unusual; the specific gravity is very high, and the oil contained over 50 per cent. of esters, calculated as menthyl acetate, against a maximum of 21 per cent. recorded for English peppermint oil.

The oil from Molo has constants mostly falling within the ranges of figures recorded for English and American peppermint oils, but the optical rotation and menthol content are beyond the ordinary limits for such oils.

The oils were submitted to firms of essential oil distillers and dealers in London, who furnished the following observations regarding them:

(*a*) " The oils from Ngong and Kipipiri are very different in character from the usual types of commercial oil, this being accompanied by a marked difference in odour and flavour. The characters of the oils especially differ from the usual types in that their ester contents, total acetylisable constituents and specific gravities are much higher than is usual.

"We do not care for the odour or flavour of either oil, and do not think they are likely to find favour among peppermint oil users. The oil from Ngong plants possesses an unpleasant pennyroyal-like note, while the oil from Kipipiri plants, though an improvement on the Ngong oil, is not of true peppermint type.

"The characters of the oil from Molo more nearly resemble those of ordinary commercial oils, but the flavour of this oil we find to be very coarse and strong."

(*b*) "The odour of the Ngong and Kipipiri oils is very strong, and there is the possibility that they might be used for dental creams, etc. Both samples are abnormal.

"In our opinion the oil from Molo is a very fine peppermint oil, and the odour is close to that of Mitcham and is superior to the Ukrainian. It is also superior, in our opinion, to the American, French and Italian peppermints, and should find a ready market. It is very difficult to value it, but we think it should obtain a figure of from 15*s*. to 20*s*. per lb."

(*c*) Only samples of the Ngong and Molo oils could be submitted to a third firm as the supply of the Kipipiri oil was exhausted. They reported as follows:

"We have looked very carefully at the two samples and it is very difficult to give an opinion which would be of much assistance to the grower. Both the oils are definitely different from anything being used at the present time on this market. The sample from Ngong is the more pungent of the two, but it has a certain sharpness about it which we do not quite like. Otherwise it appears quite a nice oil.

"The sample from Molo has a smell which one would associate with an oil that has only just left the still. It may be that the sample was taken immediately after distillation.

"After leaving papers dipped in the oils to dry for some time, we find that the smell is in both cases quite pleasant, the sample from the Molo oil under these conditions being, if anything, better than the other."

A sample of the Molo oil was also submitted to a firm of importers in London, who regarded it as fully equal in quality to American peppermint oil currently selling at about 13*s*. per lb. (November 1933), and were of opinion that they could obtain this price for consignments. They pointed out, however, that peppermint oils tend to vary considerably from year to year, so that on another occasion the Molo oil might be inferior, or on the other hand superior, to the American product.

The results of this investigation show that the oils from Ngong and Kipipiri possess abnormal physical and chemical characters. The reports of trade experts also indicate that their odour and flavour differ from those of commercial peppermint oils and would make it difficult to market such oils in this country. It will be desirable to examine further samples of the oils from these two localities in order to determine whether there is any variation in the characters of the oil obtained in successive distillations.

The Molo oil conforms more nearly in its constants to English and American peppermint oils, and although trade opinions vary as to its quality and value it was generally considered to be superior to the Ngong and Kipipiri oils. There is no doubt that a market can be found for this oil if it can be produced in commercial quantities and of constant character.

Report No. 3.—A sample of peppermint oil, representing the second distillation of plants grown at Kipipiri, was forwarded to the Imperial Institute by the Senior Agricultural Chemist in December 1933, for comparison with the sample from the first distillation dealt with in the previous report.

The sample consisted of a clear, pale brownish-yellow oil. It was found to have the following constants, which are shown in comparison with the corresponding figures obtained with the previous sample from Kipipiri and those recorded for commercial English and American peppermint oils :

—	Present sample.	Previous sample from Kipipiri	English peppermint oil.	American peppermint oil.
Specific gravity at 15·5/15·5° C.	0·9188	0·9415	0·900 to 0·912	0·899 to 0·915
Optical rotation α_D	− 41·79° at 17° C.	− 24·53° at 23° C.	− 23° to − 33°	− 20° to − 35°
Refractive index, n_D 20° C.	1·4590	1·4627	1·4600 to 1·4640	1·4600 to 1·4635
Acid value	1·6	5·0	—	—
Ester value	94·4	147·4	—	—
equivalent to esters (as menthyl acetate) . *per cent*	33·4	52·1	3 to 21	5 to 9
Ester value after acetylation	234·6	239·2	—	—
equivalent to "total alcohols" (as menthol) *per cent*	79·3	81·2	50 to 68	48 to 63
Solubility in 70 per cent alcohol at 15·5° C.	Soluble in 3 vols with slight opalescence, becoming turbid with more than 3·5 vols	Soluble in 5·2 vols	Soluble in 3 to 4 vols	Soluble in 3 to 5 vols., sometimes with opalescence.

These results show that the present sample of oil from the second distillation at Kipipiri contained about the same amount of total menthol as the previous sample, but a lower percentage of menthol as esters. It will be noted that the present oil had an abnormally high optical rotation, but that its specific gravity was considerably lower than that of the previous sample from Kipipiri and was comparable with that of English and American peppermint oils.

The odour of the present oil was more satisfactory than that of the previous sample from Kipipiri, but inferior to that of the Molo peppermint oil dealt with on page 210.

The oil was submitted to a firm of importers in London who had previously examined the Molo oil, and they furnished the following observations :

> " We find the oil of good quality, though not so good as the Molo oil which you submitted to us some time ago. It is impossible to base a valuation on a sample too small for practical tests, but we are of the opinion that this oil is of sufficiently high quality to justify production on a commercial scale."

In view of the fact that the present sample differs in character from that representing the first distillation at Kipipiri, it was suggested to the Kenya authorities that further samples of oil from later crops of the plants might be distilled and forwarded to the Imperial Institute for examination, in order to ascertain whether the variations continue or whether successive distillations tend to produce oils of uniform quality.

PEPPERMINT OIL FROM TANGANYIKA

A sample of oil prepared from plants grown at Arusha was forwarded by the Director of Agriculture in August 1931. The plants had been raised from material sent out from Mitcham in 1930.

The sample consisted of a very pale yellow, almost colourless oil. It was submitted to examination with the following results, which are compared below with the recorded figures for English and American peppermint oils and for the Japanese dementholised oil, and also with the requirements of the British Pharmacopœia :

	Present sample	B P requirements	Recorded figures for		
			English peppermint oil	American peppermint oil	Japanese dementholised peppermint oil
Specific gravity at 15 5/15 5° C	0 9346	0 900 to 0 920	0 900 to 0 912	0 899 to 0 915	0 895 to 0 905
Optical rotation α_D .	+ 10 36° at 21° C	− 20° to − 35°	− 23° to − 33°	− 20° to − 35°	− 26° to − 35°
Refractive index, n_D 20° C	1 4674	—	1 4600 to 1 4640	1 4600 to 1 4635	1 4590 to 1 4630
Acid value. . .	0 7	—	—	—	—
Ester value . .	50 6	—	—	—	—
Equivalent to menthyl acetate *per cent*	17 9	not less than 5	3 to 21	5 to 9	5 to 17
Ester value after acetylation .	149 5	—	—	—	—
Equivalent to " total menthol " *per cent*	46 9	not less than 50	50 to 68	48 to 63	40 to 54
Solubility in 70 per cent alcohol at 15 5° C.	Not clear even in 12 vols [1]	1 in 4 vols	1 in 3 to 4 vols	1 in 3 to 5 vols sometimes with opalescence	—

[1] *One volume of the oil was soluble in* 1 4 *volumes of* 80 *per cent alcohol at* 15·5° *C.*

These results show that the present oil differed considerably in character from commercial peppermint oils, especially with regard to the optical rotation and specific gravity. It will also be observed that the oil contained a rather low percentage of " total menthol " and was somewhat lacking in solubility.

The oil was submitted to (*a*) essential oil distillers and (*b*) importers of peppermint oil in London, who furnished the following observations :

(*a*) " We have examined the sample with very great interest. The oil has a nice clean smell, but it is different from either English or American oils. With regard to the analysis, the oil does not comply with the requirements of the British Pharmacopœia, particularly from the point of specific gravity, optical rotation, ester percentage and free menthol percentage.

" Taking everything into consideration, we are of the opinion that it might be difficult to get the oil placed in this country. In the first place, it has the drawback of not complying with the British Pharmacopœia, but that of course would be a minor consideration, as the bulk of peppermint oil is used for confectionery and similar flavouring purposes.

" The distiller would have to be able to guarantee to supply regularly oil of a standard quality, both with regard to flavour and other characteristics. If this can be guaranteed, it might be possible to get some manufacturers, anyhow, to look at the samples, but unless continuity and even quality can be guaranteed, they will not be interested at all. If these can be assured and a price quoted which would come below the market price of American peppermint oil, we think there are possibilities of business."

(*b*) " We were surprised to see from the constants that you send us that this oil has a plus optical rotation, for in our experience of American, Japanese, Italo-Mitcham and other qualities, peppermint oil usually has a minus rotation of from 22 to 30. The perfume is crude, and although rather preferable to the dementholised Japanese, we consider it inferior to American. The percentage of menthyl acetate is high, although the ' total menthol ' is on the low side.

"We consider the value to be in the neighbourhood of 5*s.* to 5*s.* 3*d.* per lb., but one would probably not realise this figure with a small 'odd-lot' shipment. Our idea is based on the possibility of regular supplies in which consumers can take an interest."

On the date of the above valuation, American oil was quoted in London at 9s. to 9*s.* 3*d.* per lb. and dementholised Japanese peppermint oil at 4*s.* 4½*d.* to 4*s.* 7½*d.* per lb. (November 1931).

This oil possesses an aroma which is rather different from, and not so pleasant as, that of the English and American peppermint oils. It is probable that some difficulty would be experienced in disposing of small quantities of such oil owing to the constants being very different from those of the ordinary commercial peppermint oils, and in order to establish a definite market for the oil it would be necessary to offer regular consignments. In general, however, it seems rather doubtful whether the production of oil of this quality would be remunerative. It is understood that the oil had been produced in a rather crude home-made still, and its poor quality may have been due to its having become overheated during distillation.

Lemongrass Oil from Tanganyika

A sample of oil, stated to have been distilled by a planter in the Turiani area, was forwarded to the Imperial Institute by the Director of Agriculture, in September 1933.

The sample consisted of a pale greenish-yellow oil with the pleasant characteristic odour of lemongrass. Its constants are shown on page 217 in comparison with the ranges of corresponding figures recorded for East Indian lemongrass oil, obtained from *Cymbopogon flexuosus*, and for West Indian lemongrass oil, obtained from *Cymbopogon citratus.*

The examination has shown that the characters of the present sample of lemongrass oil are more in agreement with those of West Indian lemongrass oil than East Indian oil, particularly as regards specific gravity and solubility. The oil is of good quality and contains a high percentage of

—	Present sample.	East Indian lemongrass oil.	West Indian lemongrass oil.
Specific gravity at 15·5°/15·5°C	0·8846	0·899 to 0·905	0·870 to 0·912
Refractive index n_D 20° C .	1·4860	1·483 to 1·488	1·482 to 1·489
Optical rotation α_D . .	− 0·35°	+ 1·41° to − 5°	+ 0·2° to − 1°
Citral (by bisulphite method) *per cent*	81	70 to 85	53 to 83
Solubility in 70 per cent alcohol at 15·5° C	Not completely soluble even in 10 vols	Usually soluble in 1·5 to 3 vols	Usually insoluble
Solubility in 80 per cent alcohol at 15·5° C	Soluble in 1 vol., becoming slightly turbid on further dilution	Soluble	Generally insoluble, but if soluble in one volume, the oil usually becomes turbid on further dilution

citral, and its market value would be approximately equal to that of the Cochin lemongrass oil of commerce.

With reference to the question of the solubility of the different kinds of lemongrass oil, it may be mentioned that there was formerly a strong preference in the trade for a "soluble" oil, but at present little importance is attached to this feature here as the oil is now principally used as a source of citral. The most important character of the oil is, therefore, the percentage of this constituent. In order to obtain the views of the trade regarding this question, the Imperial Institute consulted two firms with special reference to this Tanganyika oil.

A large firm of essential oil distillers stated that so far as the usefulness of lemongrass oil is concerned it does not matter whether it is of the soluble or insoluble type, as the oil is used principally as a source of citral and its value is dependent on the amount present. Even when the oil is employed in the preparation of cheap perfumes, a soluble oil is not necessarily more useful. The insolubility of a particular sample may suggest that the oil had not been properly prepared, or had been badly stored. It is well known that lemongrass oils depreciate in citral content and become less soluble on storage, especially when the oil is wet. The firm expressed their willingness to purchase insoluble lemongrass oils of good quality containing satisfactory percentages of citral.

A sample of the oil from the Turiani area was submitted to a well-known firm of importers in London, who furnished the following observations :

> " The two most important physical characteristics of lemongrass oil are its citral content and its odour. We consider the odour of the Tanganyika sample submitted to us quite satisfactory, and the citral figure of 81 per cent. is definitely higher than the normal content of the Cochin oils, although it is approximately the usual one found in the French Colonial production.
>
> " Lemongrass oil is not often used in perfumery except after rectification, and therefore the solubility is not, in our opinion, very important. We have checked this point up with one of the biggest soap-makers in the country, and also with one or two of the manufacturers of ionone, and they tell us that from their point of view they would certainly pay as much money for this Tanganyika oil as for the more soluble Cochin oil, provided the odour is good."

Different suggestions have been put forward to account for the insolubility of lemongrass oil. In some cases it is no doubt due, as suggested above, to faulty methods of preparation and bad storage, but in the case of West Indian lemongrass oil the insolubility is generally regarded as characteristic of the oil from this species (*Cymbopogon citratus*). The Tanganyika oil was characterised by a low specific gravity as well as insolubility, and these characters would appear to suggest that it was not the product of *Cymbopogon flexuosus*, but more probably that of *C. citratus*.

LEMONGRASS OIL FROM UGANDA

Two samples of lemongrass oil obtained from *Cymbopogon citratus* were received from the Director of Agriculture, in July 1931 and August 1932, respectively. The first sample consisted of a pale yellow, mobile oil, whilst the second was pale yellow and slightly turbid owing to the presence of water ; by filtration through paper, the oil was rendered clear.

The oils were found to have the following constants as compared with recorded figures for *Cymbopogon citratus* oil:

—	No 1	No 2	Recorded figures
Specific gravity at 15 5/15 5° C	0 9178	0 8846	0 870 to 0 912
Optical rotation α_D .	+ 1 43° at 20° C	− 0 21° at 22° C	− 1° to + 0 2°
Refractive index n_D 20° C .	1 4913	1 4859	1 482 to 1 489
Citral (normal sulphite method) *per cent*	72 0	74 5	—
Citral (bisulphite method) *per cent*	—	77	53 to 83
Solubility in 80 per cent alcohol	—	Insoluble even in 12 vols	Sometimes soluble, sometimes insoluble

The physical constants of Sample No 1 were slightly higher than those usually found for West Indian lemongrass oil, which is also derived from *C. citratus*. The sample was, however, of good quality and contained a fairly high percentage of citral.

Sample No. 2 was of rather better quality than No. 1, and the above figures show that its characters are in agreement with those usually found for lemongrass oil derived from *Cymbopogon citratus*.

The commercial value of these oils would be similar to that of Cochin lemongrass oil, distilled from *C. flexuosus*, which at the time the second sample was examined was quoted in London at 2*s*. 3*d*. per lb. c.i.f. (December 1932).

Oil of *Cymbopogon afronardus* from Kenya

The sample of oil which is the subject of this report was forwarded to the Imperial Institute by the Senior Agricultural Chemist in January 1934. The oil was stated to have been distilled from an indigenous grass, identified at Kew as *Cymbopogon afronardus* Stapf, which is fairly widely distributed on both sides of the Rift Valley and elsewhere. Yields of oil ranging from a trace to 0·75 per cent. had been obtained from the fresh grass at various altitudes (4,000 to 7,500 ft.), the better yields being from material growing at the higher levels.

The sample consisted of a clear, brownish-yellow oil which was found to have the following constants :

Specific gravity at 15·5/15·5° C		0·8940
Optical rotation α_D		− 0·17° at 19° C.
Refractive index n_D 20° C		1·4755
Acid value		1·4
Ester value		52·0
equivalent to esters ($C_{10}H_{17}O\ CO\ CH_3$)	*per cent*	18 2
Ester value after acetylation		249 1
equivalent to " total alcohols " ($C_{10}H_{18}O$)	*per cent*	84·2
Aldehydes and/or ketones (by normal sulphite method)	*per cent*	3·0
Solubility in 70 per cent alcohol at 15 5° C		Soluble in 1 7 vols. No turbidity on further dilution

The essential oil of *C. afronardus* does not appear to have been examined previously. In its constants as shown above, and also in odour, the present sample more resembled palmarosa oil (derived from *Cymbopogon Martini* Stapf, var. *Motia*) than any other commercial oil. Judging from its odour the oil appeared to contain a considerable proportion of geraniol, but the odour was weaker and not so rose-like as that of palmarosa oil owing to the presence of other constituents which imparted a distinct lemon-like odour. On freeing the oil from the small amount of aldehydes present, the odour was somewhat improved.

The oil was submitted to a firm of essential oil dealers in London, who expressed the opinion that the odour was not sufficiently attractive to justify production of the oil on a commercial scale. On the other hand, the high " alcohol " content of the oil might render it of value, but a sample of at least 1 or 2 lb. would be required in order to report fully on this point.

A firm of essential oil distillers, to whom the oil was also submitted, considered that the losses on saponification would be too high to make the oil of interest as a source of geraniol, but that it might find a use for soap perfumes and certain compounded products.

Further investigation of this oil is clearly desirable, and the authorities in Kenya have been asked to supply, if possible, a larger quantity for detailed chemical examination and commercial trials.

VETIVER ROOTS FROM UGANDA

Two samples of vetiver roots grown experimentally in Uganda by the Department of Agriculture have been received for examination in order to ascertain their value as a source of oil. The first sample was forwarded by the Economic Botanist at Kampala in January 1931, and the second by the Director of Agriculture in January 1933. They were as follows :

No. 1.—Roots planted in April 1930 and dug in November of the same year. They were yellowish-brown in colour, in good clean condition, with the characteristic odour of vetiver. The material was practically free from rhizomes.

No. 2.—Roots planted in November 1930 and dug in August 1932. The sample was similar to No. 1, but of somewhat paler colour.

The roots were ground and submitted to steam distillation, until practically the whole of the oil was extracted. Sample No. 1 yielded 1·2 per cent. of oil and No. 2, 1·8 per cent. The oils were found to have the following constants, which are shown in comparison with the figures recorded for vetiver oil distilled in Europe from dried roots and for that produced in Réunion :

	Specific gravity 15·5/15·5° C	Optical rotation α_D	Refractive index n_D 20° C
Sample No 1	1·0477	Too dark to obtain reading	1·5222
Sample No 2	1·0383	do.	1·5248
European-distilled oil	1·014 to 1·040	+ 25° to + 38°	1·5210 to 1·5270
Réunion oil	0·980 to 1·020	+ 15° to + 37°	1·5150 to 1·5280

Both oils possessed a fairly good aroma, and their physical constants corresponded with those of oil distilled in Europe from dried vetiver roots.

Specimens of the roots of Sample No. 2 and of the oil distilled from them at the Imperial Institute were submitted to two firms of essential oil distillers in London, who furnished the following reports :

(*a*) " Regarding the sample of oil which you sent to us, we passed this on to our laboratory, and they reported that the odour compares very favourably with English-distilled oil which we have in stock, and is much superior to the samples of imported oil. If this oil could be produced on the spot in Uganda there might be some possibilities for it, but in any case the amount of vetiver used is not very great. Most of the oil is imported from Java and Bourbon and sold at a price with which we cannot possibly compete : in small quantities the former is realising about 25*s.* per lb. and the latter about 15*s.* per lb. (June 1933).

" We have in stock vetiver oil which we distilled a good while ago, but are quite unable to sell it for the reason stated above.

" The cost of distillation of this root, as you will realise from your experimental work, is very high, so that the value of the raw material is necessarily small."

(*b*) " Our laboratory have now had the opportunity of examining the sample of vetiver oil distilled at the Imperial Institute from roots received from Uganda. This oil has a specific gravity of 1·0383 and refractive index of 1·5248 with an acid value of 76·7 per cent. and an ester value of 22·7 per cent. It is soluble in 1 volume of 80 per cent. alcohol, but clouds on further addition of 80 per cent. alcohol and does not clear in large excess.

" The sample is certainly fine-quality oil, but it is probable that oil distilled in Uganda would not be of equal quality ; in our opinion, however, it should find equal favour with the Bourbon and Java oils of the same type."

A firm of brokers who had recently offered a consignment of vetiver root at auction were also consulted with respect to Sample No. 2. They reported that the demand for the root in London is very limited at the present time, and that although there has been a small trade in Indian supplies at 20*s.* per cwt. it is difficult, even at this low price, to interest buyers in any large quantity of material (June 1933).

Sample No. 2 furnished more oil than No. 1, but the yield of 1·8 per cent., although probably equal to that obtained from some of the consignments of vetiver root distilled commercially in Europe, is only a little more than half that obtained from the best sample of roots previously examined at the Imperial Institute and much below the highest yield (about 4 per cent.) recorded in Java. It would moreover not prove economical in practice to obtain from the roots the total content of 1·8 per cent. of oil, as a stage in the distillation would be reached at which the oil would distil over so slowly that the value of the extra amount of oil obtained would not compensate for the cost of the steam required to produce it and the labour involved in extracting the oil from the large volume of aqueous distillate. In view of the comparatively small yield of oil obtainable and the difficulties connected with the distillation of vetiver oil it seems doubtful whether roots of the quality of even the better of the two samples could be profitably distilled in Uganda. It also appears unlikely that the dried roots would be readily saleable in the United Kingdom at a remunerative price.

EUCALYPTUS CITRIODORA OIL FROM KENYA

A sample of *Eucalyptus citriodora* oil which had been distilled in the Scott Agricultural Laboratories at Nairobi was forwarded by the Agricultural Chemist in December 1930. It consisted of a clear, almost colourless oil, with the characteristic odour of *E. citriodora*.

The oil was found to have the following constants, which are shown in comparison with those recorded for the oil of *Eucalyptus citriodora* :

—	Present sample	Recorded figures
Specific gravity at 15·5°/15·5° C .	0·8723	0·861 to 0·905
Optical rotation a_D 22° C . . .	+ 2·79°	− 1·15° to + 2·0
Refractive index n_D 20° C .	1·4521	1·4498 to 1·4678
Acid value	3·8	—
Ester value . . .	11·1	—
Ester value after acetylation	277·7	—
equivalent to total acetylisable constituents (expressed as $C_{10}H_{18}O$) *per cent*	96·5	Up to 98·5
Solubility in 70 per cent alcohol .	Soluble in 2·9 vols at 15·5° C	Many oils soluble in 4 to 6 vols.

These results show that the present sample is of good quality, containing a high proportion of acetylisable constituents which probably consist mainly of citronellal.

The oil was submitted to two firms of essential oil distillers in London, who furnished the following reports respectively :

(1) " This seems to be an ordinary oil of *E. citriodora* and is of a satisfactory type. The use of the oil is, however, very restricted, as in most cases the cheaper Java citronella oil answers the purpose fairly well. For a limited use the value is about 7*s*. per lb."

(2) " The oil is similar to others produced in East Africa, although it is somewhat more pungent in odour. The East African oils are not favoured by consumers who prefer the Australian distillation, which may be due to prejudice. The value of the oil would be between 4*s*. 6*d*. and 5*s*. 6*d*. per lb."

E. citriodora oil is not regularly quoted on the London market, and it will be seen that the two firms mentioned above assigned different values to the sample. In large quantities the oil would probably not meet with a ready demand unless it were offered in competition with Java citronella oil (containing 80–92 per cent. of acetylisable constituents), the price of which in London at the time of the report was only 2*s*. 1*d*. per lb. c.i.f. (August 1931).

PATCHOULI OIL FROM UGANDA

Two samples of patchouli oil were received from the Director of Agriculture, Uganda, in July 1931 and August 1932, respectively. Sample No. 1 was a yellow, fairly mobile oil, whilst No. 2 consisted of pale greenish-yellow, slightly turbid oil ; by filtration through paper the oil was rendered clear.

The oils were examined with the results which are shown on page 225 in comparison with the corresponding figures recorded for commercial Singapore and Java patchouli oils.

It will be seen that the physical constants of these oils from Uganda differed considerably from those of Singapore patchouli oil, and more resembled those recorded for the

	No. 1	No. 2	Figures recorded for oils from	
			Singapore	Java
Specific gravity at 15.5/15.5° C	0.9443	0.9271	0.960 to 0.985	0.925 to 0.935
Optical rotation α_D .	− 12.6° at 20° C	− 1.3° at 21° C	− 45° to − 65°	+ 3° to − 33°
Refractive index, n_D 20° C	1.5048	1.5021	1.5080 to 1.5120	1.5000 to 1.5080
Acid value .	—	0.3	—	—
Ester value	—	5.8	—	—
Solubility in 90 per cent alcohol	Slightly turbid with 7 vols., not entirely soluble in 10 vols.	Soluble in 7 vols.	1.5 to 7 Usually soluble in 3 to 10 vols. Some oils in 1 vol. or less	6 to 20 Soluble in up to 10 vols.

Java product, especially in the case of Sample No. 2. The odour and solubility of the second sample were more satisfactory than those of No. 1.

The second sample of oil was submitted to three firms of importers and two firms of essential oil distillers, who furnished the following reports.

Importers

(*a*) "It is quite likely that this oil would compete favourably with the Java oil, but we ourselves have not found much demand for the latter product. The perfumery houses invariably stipulate for Singapore oil, owing to its solubility and high gravity. Nevertheless there may be certain productions in which this oil could be used, provided the price was at a favourable level."

(*b*) "The sample, we regret to say, is undoubtedly a very inferior oil. The odour is bad and we are quite sure there would be the greatest difficulty in interesting buyers in it. The analysis shows it to be similar to Java patchouli oil, but it is so very inferior to it in odour that there would not be any hope of its being able to compete with that oil. For these reasons we cannot recommend the production of an oil similar to this sample on a commercial scale, and we regret that in this instance we are unable to make any helpful suggestions.

"The production of patchouli oil appears to be increasing. For example the Seychelles Islands are now exporting to this country at least more oil than they have ever done before. Meanwhile supplies from Singapore, which has always been the more important centre of production, are fully maintained."

(*c*) " This oil has an unusual odour quite different from the ordinary patchouli oils of commerce. In fact, its odour could almost be described as unpleasant and we do not think that it is likely to find much demand, especially in view of the fact that other patchouli oils are in plentiful supply at unprecedentedly low prices."

Essential Oil Distillers

(*a*) " The odour of this oil is apparently quite clean, but rather thin, and distinct from that of Singapore or Seychelles patchouli."

(*b*) " With regard to this oil, it is of very inferior odour compared with that distilled in this country from imported leaves, or that imported as such. There is no oil on the market which it could supersede, and hence its commercial value would be very low."

The results of this investigation suggest that the patchouli plants which are being grown in Uganda yield an oil of relatively poor quality and value. It is very doubtful whether it would be profitable to produce such oil on a commercial scale.

Patchouli oil, to be readily marketable, should approach the quality of the Singapore product, which is taken as a standard in the trade, and is at present quoted in London at about 6*s*. per lb. (spot, May 1934). The best oils usually possess a high specific gravity and are soluble in an equal volume (or less) of 90 per cent. alcohol.

The fact that these samples of Uganda oil resembled the Java oil in characters suggests that the plants now being cultivated were obtained from the latter country. It was intimated to the authorities that if this be so it would be desirable to procure a supply of the plants yielding the Singapore oil for trial cultivation and distillation in Uganda.

CINNAMON LEAF OIL FROM UGANDA

A sample of cinnamon leaf oil was forwarded to the Imperial Institute by the Director of Agriculture, in August 1932. It was reddish-brown in colour, and slightly turbid owing to the presence of water. By filtration through paper, the oil was rendered clear.

The oil was found to have the following constants as compared with those of samples of cinnamon leaf oils from Seychelles examined at the Imperial Institute, and the recorded range for Ceylon cinnamon leaf oil.

—	Present sample	Seychelles cinnamon leaf oil	Ceylon cinnamon leaf oil
Specific gravity at 15·5/15·5° C	1·0477	1·046 to 1·060	1·044 to 1·065
Optical rotation α_D . .	+ 1·3° (approx., solution very dark) at 22° C	− 2·06° to + 0·25°	− 0·25° to + 2·33°
Refractive index n_D 20° C .	1·5364	1·532 to 1·539	1·531 to 1·540
Total phenols (as eugenol) *per cent*	69·5	86 to 92	65 to 95
Aldehydes (bisulphite method) *per cent*	5·5	0·5 to 6·5	Up to 4
Solubility in 70 per cent alcohol	Soluble in 1·6 vols. No turbidity on further dilution	Soluble in 1·1 to 1·5 vols. No turbidity on further dilution	Soluble in 1 to 3 vols. Sometimes becoming turbid on further dilution

The present sample of cinnamon leaf oil is similar in character to the oil distilled in Ceylon and Seychelles, but it contains a rather lower percentage of eugenol than average samples of the commercial oils.

Cinnamon leaf oil is used principally as a source of eugenol for the manufacture of vanillin. The bulk of the commercial oil goes to the United States where it is admitted free of duty. Owing to the steadily increasing competition of vanillin made from guaiacol during recent years, the value of cinnamon leaf oil has declined, and, moreover, at the present time, this oil has to compete with Madagascar clove oil as a source of eugenol. The latter oil is now quoted in London at 2*s*. 4½*d*. per lb. c.i.f., on a basis of 85 per cent. of eugenol (May 1934).

Another factor in this connection is that clove oil is more suitable than cinnamon leaf oil for vanillin manufacture, as the constituents other than eugenol in the latter oil render the vanillin more difficult to purify than the vanillin produced from clove oil.

Cinnamon leaf oil is at present quoted in London at 2*s*. 6*d*. per lb. c.i.f. (May 1934) and this oil from Uganda containing only 70 per cent. of eugenol would probably realise rather less than this price.

Aframomum amaniense Oil from Tanganyika

As mentioned in Dr. Worsley's paper on "Some East African Essential Oils," published later in this Bulletin (p. 253), a sample of oil distilled from the seeds of *Aframomum amaniense* (Nat. Ord. Zingiberaceæ), was sent to the Imperial Institute under the name "natural geraniol" oil. At the time of sending the oil, in October 1932, the actual source of the sample was not stated and the oil was examined at the Imperial Institute in comparison with commercial geranium oils.

The sample consisted of 1½ oz. of a clear, almost colourless oil. It had an odour of geraniol, which, however, was not very intense and was modified by a rather unpleasant subsidiary odour.

The oil was found to have the following constants, which are shown in comparison with the figures recorded for commercial Algerian and Bourbon geranium oils :

	Present sample of "geraniol" oil	Commercial geranium oils	
		Algerian	Bourbon
Specific gravity at 15·5/15·5° C	0·8966	0·892 to 0·904	0·888 to 0·8965
Optical rotation α_D . .	− 4·68° at 16 C.	− 7° to − 11·5°	− 8° to − 14°
Refractive index n_D 20° C .	1·4743	1·4650 to 1·4720	1·4620 to 1·4677
Acid value	0·7	1·5 to 10	1·5 to 10
Ester value	69·5	40 to 70 (rarely as low as 36)	50 to 78 (rarely below 55)
Ester value after acetylation	233·6	200 to 230	205 to 230
equivalent to "total alcohols" (expressed as geraniol) . *per cent*	77·9	64·7 to 76·4	66·6 to 76·4
Solubility in 70 per cent alcohol at 15·5° C.	Soluble in 2 vols	Soluble in 2·5 to 3 vols.	

Apart from slight differences in the optical rotation and refractive index, the constants of the present oil agree well with those of commercial geranium oils, and the oil contains a high percentage of " total alcohols " calculated as geraniol.

A firm of essential oil distillers to whom the oil was submitted furnished the following observations :

> " From an odour point of view, compared with standard types of commercial geranium oils the product is very inferior, having a sort of ' peppery ' note, and also suggests gingergrass oil rather than geranium. It could not replace ordinary geranium oils in commerce, but from the point of view of value we should say that it is about equal to that of a high-grade citronella oil, which would be about 2*s*. 4*d*. per lb."

With reference to this valuation, it may be mentioned that the price of Bourbon geranium oil in London at the time was 23*s*. per lb., and of the Algerian oil 23*s*. 6*d*. per lb. (January 1933).

It will be seen from the results of this investigation that this oil does not possess the usual character of the geranium oils of commerce and would not be able to compete with these in the market. It is possible that if supplied in regular quantities it might find a use for some special purpose, but its value would be much below that of the Algerian and Bourbon geranium oils of commerce.

MUHUGU OIL (*BRACHYLÆNA HUTCHINSII*) FROM KENYA

A sample of Muhugu oil, distilled in Kenya from the wood of *Brachylæna Hutchinsii* (Nat. Ord. Compositæ), was examined at the Imperial Institute in 1931 (see this BULLETIN, 1931, **29**, 433). The results showed that owing to its pleasant and persistent odour the product offered possibilities for use in soap perfumery and as a fixative.

In continuation of that investigation three further samples of the oil were forwarded to the Imperial Institute by the Senior Agricultural Chemist in June 1933. These samples represented three fractions obtained on the distillation of the wood of the coastal variety of *B. Hutchinsii*, and had been prepared in order to ascertain how far the distillation should be carried in working on a commercial scale. The proportions in which the three fractions were obtained (Nos. 1, 2 and 3) were stated to be 50 : 26 : 10.

All three oils, as received, were slightly turbid owing to the presence of a small amount of resinous material in suspension. On filtration, clear oils were obtained with the following characteristics:

1st Fraction.—A pale yellowish-brown, somewhat viscous, oil.

2nd Fraction.—A yellowish-brown oil, darker than the 1st fraction and rather more viscous.

3rd Fraction.—A rather dark yellowish-brown oil, considerably more viscous than the 2nd fraction.

On standing, the filtered oils all became turbid again, owing to the separation of a further amount of resinous material.

The oils were examined with the following results, which are shown in comparison with those of the unfractionated Muhugu oil previously received at the Imperial Institute:

—	Present samples			Entire oil examined in 1931.
	1st Fraction	2nd Fraction	3rd Fraction	
Specific gravity at 15·5/15·5° C	0·9719	0·9905	0·9961	0·9743
Optical rotation α_D	+ 3·19° at 25° C	− 8·0° at 25° C	− 9·54° at 23° C	− 1·91° at 24° C
Refractive index, n_D 20° C	1·5108	1·5138	1·5170	1·5103
Acid value	0·7	1·1	1·4	1·2
Ester value	10·8	17·2	18·3	10·1
Ester value after acetylation	89·4	143·5	155·1	101·8
Solubility in 80 per cent alcohol at 15 15° C	Soluble in 20·7 vols with slight turbidity	Soluble in 1·5 vols	Soluble in 1·2 vols	Insoluble even with 30 vols
Solubility in 90 per cent alcohol at 15·5° C.	Soluble in 0·3 vol	Miscible in all proportions	Miscible in all proportions	Soluble in 0·3 vol.

It will be observed from these results that the physical and chemical constants of the three fractions show marked differences. As would be expected, the specific gravity has increased in the later fractions of the oil, and these fractions contain a greater proportion of alcohols, thus increasing the solubility of the oil.

Fraction No. 1 had the most pronounced odour of the three oils, somewhat resembling that of cedar-wood oil. It appeared to contain a larger proportion of a more volatile constituent, for on exposure of small quantities of the oil to the air its odour became more subdued and finally approximated to that of the two other fractions. Fraction No. 2 did not differ appreciably in odour from No. 3, and it seems unlikely that there would be any material difference in the commercial value of these two fractions.

Samples of the three fractions were submitted to a firm of essential oil distillers who had reported favourably on the sample of unfractionated oil forwarded in 1931. They furnished the following observations :

> " The sample representing the first fraction is certainly saleable, but in our opinion the second and third fractions contain valuable constituents and we think that it would be inadvisable to omit these last volatile portions of the oil from the bulk. The third fraction has a soft vetiver-like odour, whereas the first fraction more nearly compares with cedar-wood oil, and therefore the quality of the oil would be lowered if the distillation were stopped before the wood is completely exhausted."

It seems clear from the results of the present investigation that the value of the Muhugu oil would be much reduced if the higher fractions were not included, as these contain the constituents which cause the oil to resemble vetiver oil, for which it might perhaps be used to some extent as a substitute. The odour of the first fraction is inferior in this respect and more resembles commercial cedar-wood oil, which is only worth about 1*s*. 6*d*. per lb. It would appear, therefore, that the best method of preparing Muhugu oil would be to distil the wood as nearly to exhaustion as may be practicable.

KAWAMALA (*COLEUS* SP.) OIL FROM UGANDA

Samples of oil distilled from a species of *Coleus* (Nat. Ord. Labiatæ), known in Uganda as Kawamala, were received from the Director of Agriculture in July 1931 and October 1932 respectively. The first sample consisted of a pale yellow, mobile oil. The second sample was turbid when received owing to the presence of moisture ; after filtration through paper it was clear and of pale yellow colour.

The two oils were examined with the following results :

	No 1	No 2
Specific gravity at 15·5/15·5° C.	0·8859	0·8815
Optical rotation α_D	+ 43·0° at 16° C.	+ 29·93° at 19° C.
Refractive index n_D 20° C.	1·4828	1·4808
Acid value	—	0·6
Ester value	—	18·3
Ester value after acetylation	—	42·3
Aldehydes and/or ketones (by the bisulphite method) *per cent.*	—	3·5
Phenols (by absorption) *per cent.*	—	1·5
Solubility in 90 per cent. alcohol at 15·5° C.	—	Not completely soluble even in 10 vols.

The second sample of oil was submitted to (*a*) essential oil distillers, and (*b*) soap manufacturers, who furnished the following observations :

(*a*) " This oil is of little interest and is unlikely to find favour here except for the cheap soap trade."

(*b*) " The oil is difficult to describe and recalls in its odour a mixture of the terpenes obtained from oils containing cineole and thymol to which is added a suggestion of the spicy odour of nutmeg. Such a mixture would approximate quite closely to the odour of this oil. Its market price would be low, probably less than 2*s*. per lb." (March 1933).

The odour of both samples of oil, though rather pleasant, was not strong or very distinctive. This character, and also the low solubility and low specific gravity, indicate that the oil consists largely of terpenes. The figure obtained for the ester value after acetylation is equivalent to about 12 per cent. of "total alcohols" (calculated as $C_{10}H_{18}O$) in the original oil.

The results of examination show that the oil would only be marketable at a low price for soap perfumery, and that it contains no constituents of commercial value in sufficient quantity to be worth extraction.

OIL OF *COLEUS* SP. FROM UGANDA

Accompanying the second sample of Kawamala oil from Uganda was another Coleus oil, stated to have been obtained from a fleshy-leaved species of *Coleus*.

The oil was turbid owing to the presence of moisture; after filtration through paper it was clear and of pale yellow colour.

The oil was found to have the following constants:

Specific gravity at 15 5/15 5° C	0 8939
Optical rotation a_D	– 20 33° at 19° C
Refractive index n_D 20° C	1 4940
Acid value	0 7
Aldehydes and/or ketones (by the bisulphite method) *per cent*	2 5
Phenols (by absorption) *per cent*	6 0
Solubility in 90 per cent alcohol at 15 5° C	Not completely soluble even in 10 vols
[1] Ester value	7 6
[1] Ester value after acetylation	35 0

[1] *Determined on the phenol free oil.*

The phenols were extracted from a portion of the sample by shaking with a 5 per cent. solution of caustic potash. Most of the phenols in the alkaline solution could be removed by direct extraction with ether. This portion, which possessed a thymol-like odour, did not completely congeal when cooled with solid carbon dioxide. This suggested that the odour was due to carvacrol which, when pure, melts at 0·5° to 1° C. The presence of carvacrol was confirmed by the preparation of the crystalline nitroso-compound, melting at 153° C.

The quantity of phenols not extracted by means of ether from the alkaline solution was insufficient for complete examination and identification.

The oil was submitted to (*a*) essential oil distillers and (*b*) soap manufacturers, who furnished the following observations :

> (*a*) " This oil is of little interest, and is unlikely to find favour here except for the cheap soap trade."
>
> (*b*) " Products containing this oil developed a peculiar fusty colour which would be difficult to cover, and as the oil is also weaker in odour than is desirable we are doubtful if it will be possible to find a place for it on the market."

This oil possessed a rather pleasant thyme-like odour which, however, was not strong enough to render the oil of much value for perfumery purposes. The general odour suggested the presence of a large proportion of terpenes, and this is also indicated by the low solubility, and by the chemical constants which show the presence of only very small amounts of esters, alcohols, aldehydes, and phenols. The figure obtained for the ester value after acetylation is equivalent to only 9·3 per cent. of " total alcohols " (calculated as $C_{10}H_{18}O$) in the original oil.

Carvacrol is employed as a substitute for thymol, but there is only a limited demand for it, and the small amount present in this oil would not be worth extraction.

OIL OF *COLEUS* SP. FROM KENYA

The sample of oil which is the subject of this report was forwarded to the Imperial Institute by the Senior Agricultural Chemist in December 1933. The oil was stated to have been distilled experimentally from a species of Coleus growing freely at Limuru, and it was desired to ascertain its commercial possibilities.

The sample consisted of a clear, greenish-yellow oil, with a pleasant, somewhat spicy odour. The oil was found to have the following constants :

Specific gravity at 15·5/15·5° C.	0·9139
Optical rotation α_D	− 25·91° at 16° C
Refractive index n_D 20° C	1·4950
Solubility in 90 per cent alcohol at 15·5° C.	Not completely soluble even in 10 vols.

No chemical examination of the oil was possible, owing to the small quantity available, but the physical constants indicate that it consists principally of terpenes. The oil had not a strong odour, although it would appear to contain some cineole.

The physical constants of the oil are rather similar to those of the sample of Uganda oil from " fleshy-leaved " Coleus dealt with on page 233, but the odour of the present sample was pleasanter, and was more like that of the " Kawamala " oils from Uganda though more spicy.

The oil appeared unlikely to be of commercial interest except possibly in soap perfumery, and it was therefore submitted for valuation to a firm of soap manufacturers, who furnished the following observations :

" This oil in its initial stages has an odour of the cedar type, with a definite suggestion of the Zdravetz oil. On exposure it develops a tendency towards the bay-pimento-nutmeg group and finally reverts to the cedar type, the Zdravetz odour persisting to the end.

" The oil would not find any place in fine (handkerchief) perfumery. It could not be used in any soap compound of the floral type, but might possibly find an opening in a ' dull ' perfume of the fougère type assuming that no discoloration in soap is likely. It would not satisfactorily replace any of the oils in our present formulæ and is of the class that would, due to its pungency and persistence, only find a limited use in any sphere.

" Compared with the two samples of Coleus oil from Uganda, it is more persistent and of the same class as the Kawamala oil, but is quite different in character from the oil of the fleshy-leaved Coleus. Our estimation of its value would be slightly higher than that of Kawamala, which was previously valued at about 2*s*. per lb."

KAMYNYE (*HOSLUNDIA OPPOSITA*) OIL FROM UGANDA

A sample of oil distilled from *Hoslundia opposita* (Nat. Ord. Labiatæ), a plant known locally as Kamynye, was forwarded by the Director of Agriculture, Uganda, in July 1931. It consisted of a pale yellow, rather viscous oil.

The oil was examined with the following results :

Specific gravity at 15·5/15·5° C. . .	0·9278
Optical rotation α_D	− 11·96° at 17° C.
Refractive index n_D 20° C. . . .	1·5130

No reference to any previous examination of this oil can be traced. Apparently the oil is composed largely of sesquiterpenes and sesquiterpene alcohols. It has a rather pleasant, persistent odour, somewhat recalling that of vanillin.

The oil was submitted to a firm of essential oil distillers in London who confirmed the view that it consisted largely of constituents of the sesquiterpene class. They considered that it might find a limited application in perfumery as a fixative, but that there would not be much probability of any large consumption.

It seems unlikely that the oil would realise a price sufficient to render its production remunerative.

MUJAJA OMUNENE (*OCIMUM* SP.) OIL FROM UGANDA

Two samples of oil distilled from an indigenous species of *Ocimum* (Nat. Ord. Labiatæ), known locally as Mujaja Omunene, were received from the Director of Agriculture, Uganda, in July 1931 and October 1932 respectively. It was desired to ascertain how the oil compared with products already established on the market. Sample No. 1 was a pale brown, mobile oil, whilst No. 2 was turbid owing to the presence of moisture ; after filtration through paper it was clear and of pale yellow colour.

The oils were examined with the following results ·

	No 1	No 2
Specific gravity at 15 5/15 5° C .	0 9117	0 8955
Optical rotation α_D	— 20 21° at 16° C	— 4 25° at 18° C
Refractive index n_D 20° C . .	1·5040	1·4941
Acid value	—	1·1
Aldehydes and/or ketones (by normal sulphite method) *per cent*	—	1·0
Phenols (by absorption) *per cent.*	24	26·5
Solubility in 90 per cent alcohol at 15·5° C	—	Soluble in 0·4 vol.

The quantity of oil available in the case of sample No. 1 was insufficient for the complete examination of its constituents, but its odour indicated the presence of eugenol in the phenolic portion, whilst the non-phenolic portion of the oil appeared to consist principally of terpenes.

In the case of sample No. 2 further work on the oil was possible, and the following constants were determined on the phenol-free oil :

Ester value	10·1
Ester value after acetylation	20·5
Specific gravity at 15·5/15·5° C.	0·869

The phenols were removed from a portion of this sample by shaking it with a 5 per cent. solution of caustic potash. From the alkaline solution of the phenols so obtained some of the phenols were extracted with ether. After removal of the ether this portion was frozen by means of solid carbon dioxide, the crystals so obtained remaining solid on reaching room temperature. These crystals possessed the characteristic odour of thymol, and after purification by crystallisation from light petroleum melted at 49·5–50·5° C., their identification as thymol being thus confirmed.

The phenols not extracted by the ether from the alkaline solution were liberated by means of dilute hydrochloric acid and found to possess the clove-like odour of eugenol. The presence of eugenol was confirmed by the preparation of the benzoyl compound melting at 69° C. Small quantities of other phenols were also present.

Sample No. 2 was submitted to (*a*) essential oil distillers and (*b*) soap manufacturers, who furnished the following observations regarding the commercial value of the oil:

(*a*) " This is a very fine oil of the thyme oil type. The thymol content is too low for profitable extraction, but the oil should be very acceptable to soap-makers. It is difficult to put a value on the oil, but we think that it would be somewhere round about that of a good type of white thyme oil."

(*b*) " This oil might be described as a variant of the ordinary red thyme oil of commerce, and it possesses no characteristic which would make it of greater value than one of the lower-grade oils of this class. We have compared it with one of these oils, costing to-day 3*s*. 3*d*. per lb., and find it to be less powerful and not so persistent in odour. It does keep well, however, and is not so prone to discoloration on exposure. We find difficulty in suggesting a better market value for it than about 2*s*. 6*d*. per lb." (March 1933).

The results of examination indicate that the two samples of oil are of similar character, although No. 2 exhibits a considerably lower lævo-rotation. The detailed investigation of sample No. 2 showed that the phenolic portion of the oil, which the odour of the oil suggested was composed essentially of eugenol, also contains an appreciable proportion of thymol.

The low specific gravity of the phenol-free oil, and the low ester value after acetylation, which would be equivalent to only about 4 per cent. of "total alcohols" (calculated as $C_{10}H_{18}O$) in the original oil, show that the non-phenolic portion of the oil consists principally of terpenes.

As indicated above, the oil might perhaps be saleable for soap perfumery at a price of 2*s.* 6*d.* per lb. It does not, however, contain a sufficient amount of thymol or eugenol to render the extraction of these constituents remunerative.

OCIMUM MENTHÆFOLIUM OIL FROM UGANDA

The sample of oil which is the subject of this report was forwarded to the Imperial Institute by the Director of Agriculture in July 1931. It was stated to have been distilled from indigenous plants, and it was desired to ascertain how the oil compared with products already established on the market.

The sample consisted of an almost colourless, mobile oil. It was examined with the following results, which are shown in comparison with corresponding figures recorded by Rovesti (*Annali di Chim. Applic.*, 1927, **17**, 564), for a sample of the oil of *Ocimum menthæfolium* :

	Present sample	Recorded figures
Specific gravity . . .	0·9122 at 15·5/15·5° C	0·9496 at 25° C.
Optical rotation α_D . .	+ 13·51° at 16° C.	+ 1·4° at 22° C.
Refractive index n_D . .	1·4763 at 20° C.	1·5165 at 24° C.

It will be observed that the physical constants of the present oil differ considerably from those of the sample of oil examined by Rovesti, which was distilled from plants occurring in Eritrea. According to this investigator the odour of the oil examined by him was reminiscent of sweet basil oil, and the oil consisted largely of methyl-chavicole and anethole. The odour of the present oil, however, differs greatly from that of sweet basil oil ; it is more camphoraceous and does not indicate the presence of appreciable amounts of the above-named compounds.

This oil might realise a low price as a cheap soap perfume, but its odour is not attractive and its production in Uganda is not likely to be remunerative.

OCIMUM AMERICANUM PLANTS FROM NYASALAND

A sample consisting of about 26 lb. of dried plants of *Ocimum americanum* Linn. was forwarded for examination to the Imperial Institute by the Acting Director of Agriculture at Zomba in February 1930. The plants, which were in the flowering and seeding stage, in some cases had been uprooted from the ground and in others had been cut down. The flower heads and flower stems comprised 43 per cent. of the sample, the remaining 57 per cent. consisting of stalks and some roots.

The stalks present in the sample were submitted to steam distillation, but only a very small amount of a waxy, inodorous substance was obtained.

The flower heads and flower stems on steam distillation furnished 1·6 per cent. of a volatile oil, corresponding to a yield of 0·7 per cent. calculated on the whole original material as received. The oil so obtained was pale brownish-yellow and had a pronounced camphoraceous odour, but on cooling to − 5° C. no crystals of camphor separated.

The oil had the following constants :

Specific gravity	0·9219
Optical rotation α_D 20° C	+ 45·08°
Refractive index n_D 20° C	1·4715
Acid value	0·6
Ester value	nil
Ester value after acetylation	15·5

It will be seen from the above results that the material furnished a comparatively small yield of essential oil, and that the woody stalks which constituted the greater proportion of the sample contained no odorous constituents. The whole plant in the green state would furnish probably less than 0·5 per cent. of oil.

Judging from its odour the present oil would appear to contain camphor, but as none separated when the oil was cooled to — 5° C. the amount present could not be very high. Camphor-leaf oils usually yield about 70 per cent. of camphor when cooled to 0° C., and the residual oil contains up to about 30 per cent. of camphor which can only be isolated by fractionally distilling the oil. The amount of the present oil was not sufficient for fractionation as, although all the flower heads and flower stems in the sample of plants were distilled, they yielded only 75 c.c. of oil.

The odour of the oil is not particularly pleasant and, judging by the results of the present investigation, it could certainly not be profitably produced as a commercial source of camphor.

In this connection it is of interest to mention that *Ocimum americanum* has previously received some attention, particularly from French chemists, as a possible source of camphor, but the investigations have given contradictory results.

In 1903 Charabot recorded the presence of camphor in oil distilled from plants obtained from Mayotte, but oils from material received from the Ivory Coast and the French Congo contained methyl cinnamate and no camphor, whilst of five oils said to have been derived from *Ocimum americanum* from the Comoro Islands, one yielded camphor whereas the others contained no camphor but variable amounts of methyl cinnamate. A sample of the essential oil from plants growing in Kenya was stated by the same investigator in 1927 to have yielded about 35 per cent. of camphor, but no information was furnished as to the yield of oil from the plants ; and the amount of camphor obtainable from the whole plant, which would be important from an economic point of view, is therefore uncertain.

WOOD AND OIL OF "MLANJE CEDAR" (*WIDDRINGTONIA WHYTEI*) FROM NYASALAND

Samples of the wood of *Widdringtonia Whytei* (Nat. Ord. Coniferæ), the "Mlanje cedar" (or "cypress"), and the oil obtained therefrom by the Assistant Agricultural Chemist, were forwarded to the Imperial Institute by the Conservator of Forests in January 1933. It was desired to ascertain the commercial uses and value of the oil. Considerable quantities of the wood are stated to be available as a waste product of the timber industry.

The samples were as follows :

Oil.—A. Oil extracted by steam distillation from 80 g. Mlanje cedar. B. Oil extracted from 80 g. Mlanje cedar by steam distillation, the shavings, the water in the distillation flask and the distillate being subsequently extracted with petroleum ether and the oil isolated.

The two samples were distinctly different in odour, possibly owing to differences in the method of preparation employed. The odour of sample A resembled that of the oil distilled at the Imperial Institute as described below, whilst that of B was less pleasant and included a sharp, acrid subsidiary odour.

It was stated that a yield of 5·5 per cent. of oil was obtained in the experiment represented by sample A, and 2·7 per cent. in the case of sample B.

The samples were too small for detailed examination and the investigation of the oil has been carried out on the sample distilled from the wood at the Imperial Institute.

Wood.—This sample consisted of three boards each measuring 17½ × 7½ × 1 in. The wood was reddish-yellow, moderately hard, and had a pleasant cedar-like odour.

Distillation of the wood.—The distillation was conducted in a 10-gallon essential oil still, on the wood reduced to a coarse powder ; the contents of the still were kept in continual agitation during the distillation by means of a mechanical stirrer. The distillation was continued until the material was practically exhausted of essential oil.

The ground wood contained 8·7 per cent. of moisture and furnished a total yield of 12·9 per cent. of a limpid volatile oil, equivalent to a yield of 14·1 per cent. expressed on the moisture-free wood. The volume of aqueous distillate obtained was about 14 gallons per lb. of wood distilled. The yield of oil was more than twice as much as the maximum of 5·5 per cent. obtained in Nyasaland, although the number of parts of water collected for 1 part of the wood distilled was rather less than the amount found necessary in Nyasaland for the complete removal of the oil from the wood. The yield of oil, viz. 12·9 per cent., is exceptionally high and is much in excess of the yield from American cedar wood, which is recorded as giving 1 to 4½ per cent. of oil.

It was observed that the oil collected during the first part of the distillation possessed a stronger odour of cedar wood than the later portions. It is therefore possible that a more valuable oil would be obtained if the distillation were stopped at a certain point, but owing to the small quantity of wood available in this sample it was not feasible to carry out experiments in this direction. In any case it would probably prove uneconomical to continue the distillation to the point of complete exhaustion of the wood, as a stage would be reached after which, owing to the diminished amount of oil in the condensed vapours, the cost of the operation would be greater than the value of the additional oil extracted.

Examination of the Oil.—The oil, obtained as described above, was brownish-yellow and possessed an odour of cedar wood, which, however, was less intense than that of American or Kenya cedar-wood oil. Its constants are shown in the following table in comparison with the corresponding figures for commercial American cedar-wood oil :

	Present sample	Recorded figures for oil of American cedar
Specific gravity at 15·5/15·5° C.	0·9645	0·943 to 0·964
Optical rotation α_D	− 31° 13′ at 18° C.	− 18° to − 42°
Refractive index n_D 20° C.	1·5098	1·50 to 1·51
Acid value	7·2	Up to 1·8
Ester value	15·2	Up to 12
Ester value after acetylation	69·0	26 to 68
Solubility in 90 per cent. alcohol at 15·5° C.	Soluble in 0·5 vol., becoming turbid with 1·6 vols., finally soluble in 4·2 vols.	Soluble in 10 to 20 vols.

It will be observed that the physical and chemical constants of the Widdringtonia oil generally resemble those recorded for the oil of American cedar wood (*Juniperus virginiana*), but the ester value is somewhat higher and the oil is more soluble.

The figures for the Widdringtonia oil also agree generally with those given by some specimens of Kenya cedar-wood oil (*Juniperus procera*), but the samples of the latter oil hitherto examined have shown considerable variation.

Commercial Value.—The oil was submitted to two firms of essential oil merchants, who furnished the following observations respectively :

(*a*) " We find the odour of this oil not as full as that of the American cedar-wood oil or similar oil from Kenya. On the other hand it has a very delicate and sweet odour. The oil blends very well and could be used in quite large quantities in combination with ionones, and patchouli and vetiver oils.

" We are of the opinion that the oil would find a fairly ready sale, but it is difficult to fix a price. We should think in the first instance it might be considered at a value somewhere in the neighbourhood of 1*s.* 3*d.* to 1*s.* 6*d.* per lb."

(*b*) " This oil has an odour resembling a mixture of cedar and West Indian sandal-wood oil, with a suggestion of orris. It might have a value as a fixative for perfumery purposes. We estimate that for limited quantities it would be worth about 4*s.* per lb."

The oil was also submitted to a firm of soap manufacturers, whose Chief Chemist reported on it as follows :

" Having prepared samples of soap containing the above oil and compared it with East Indian sandal-wood oil and American cedar-wood oil, I am of opinion that it will not be possible to market it at a price above that of the American cedar, other than perhaps a small premium because of its somewhat, though only slightly, more sandal-like odour. This, however, is discounted by its weakness and consequently I cannot suggest that the premium can be a large one.

" I send for your observation samples of soaps, marked 1, 2, 3 and 4, which have been compounded and kept for some time in order to obtain a seasoning effect and thereby arrive at the true value of the oils.

" The composition of the essential oils used was as follows, 1 per cent. of the mixture being used :

" (1) 50 per cent. sandal wood, 50 per cent. cedar wood.

"(2) 50 per cent. Widdringtonia, 50 per cent. cedar wood.

"(3) 66 per cent. cedar wood, 34 per cent. sandal wood.

"(4) 100 per cent. Widdringtonia."

In connection with the foregoing commercial reports it may be mentioned that both American and Kenya cedarwood oils were quoted in London at 1*s.* 9¾*d.* per lb. in tins, spot (May 1933).

It was suggested to the authorities in Nyasaland that if, in view of the results of this investigation, it was considered desirable to proceed further in the matter, a larger sample of the wood should be forwarded to the Imperial Institute so that further distillation trials could be made and the oil collected in fractions for detailed examination in order to determine the best point to which the distillation should be carried.

In accordance with this suggestion four samples of the wood were forwarded by the Acting Conservator of Forests in July 1933. The samples were numbered 1, 2, 3 and 4, and weighed respectively 31 lb., 30 lb., 26 lb. and 31½ lb. They were as follows:

No. 1. *From Mlanje Mountain.*—Planed boards 17½ in. long, 7½ in. wide, and 1 in. thick, composed mostly of heartwood. The heartwood, which had a smooth, oily surface, was moderately hard, and pale reddish-brown in colour.

No. 2. *From Mlanje Mountain.*—Pieces of wood about 17½ in. long, 7 in. wide, and up to 2½ in. thick, representing outside portions of logs, freed from bark, as obtained in the production of planks. In all the pieces there was a very noticeable line of demarcation between the pale yellow sapwood, which extended to a depth of 1 to 1½ in. from outside of the log, and the pale reddish-brown heartwood.

No. 3. *From Thinnings in Plantations on Zomba Mountain.*—Sawn boards, 17½ in. long, 6½ to 7 in. wide, and ⅞ in. thick. The wood was moderately hard. The centre portions (heartwood) were reddish in tint, whilst the outer portions (sapwood) which extended to a depth varying from about ½ to 1 in. were pale yellow.

No. 4. *From the Plantations on Zomba Mountain.*—Pieces of wood, 17 to 17½ in. long, representing outside portions of logs freed from bark. About half the sample consisted of pieces about 7 in. wide and up to 2½ in. thick, the remainder consisting of smaller pieces varying from ¾ × 4½ to 1½ × 6 in. Pale yellow sapwood extended to a depth of about an inch from the outside of the larger pieces, and the smaller pieces consisted entirely of sapwood. There was only a small amount of heartwood in the sample.

Portions of the samples were reduced to fine sawdust and the oil was distilled from them under the conditions described on page 241. The results of the trials are given in the following table, which includes for comparison the corresponding figures obtained for the sample of wood previously examined at the Imperial Institute.

—	Present samples				Previous sample
	No 1	No 2	No 3	No 4	
Moisture *per cent*	8·3	6·4	6·5	5·9	8·7
Yield of oil expressed on original wood *per cent*	11·2	5·2	5·4	0·9	12·9
Yield of oil expressed on moisture free wood *per cent*	12·2	5·5	5·8	1·0	14·1
Gallons of aqueous distillate					
Per lb of wood distilled	12·5	6	7	1·3	14
Per lb of oil obtained	112	115	136	144	108

The constants of the volatile oils were as follows:

—	No 1	No 2	No 3	No 4	Previous sample
Specific gravity at 15·5/15·5° C	0·9679	0·9682	0·9614	0·9671	0·9645
Optical rotation α_D	− 24·98° at 21° C	− 31·73° at 21° C	− 40·82° at 21° C	− 32·21° at 21° C	− 31·13° at 18° C
Refractive index, n_D 20° C	1·5100	1·5094	1·5088	1·5090	1·5098
Acid value	6·1	6·0	8·5	4·4	7·2
Ester value	20·8	13·6	10·0	11·5	15·2
Ester value after acetylation	76·7	75·5	49·2	59·9	69·0
Solubility in 90 per cent alcohol at 15·5° C	Soluble in 0·5 vol No turbidity on further dilution	Soluble in 0·35 vol No turbidity on further dilution.	Soluble in 7 vols	Soluble in 0·4 vol No turbidity on further dilution.	Soluble in 0·5 vol, becoming turbid with 1·6 vols Finally soluble in 4·2 vols.

The yield of oil from the different samples seemed to indicate that the oil was present mainly in the heartwood. To confirm this point, some of the sapwood from sample No. 2 was distilled and a yield of only 0·1 per cent. of oil was obtained. Approximately 57 per cent. of this sample was sapwood, and as the entire wood yielded 5·2 per cent. of oil the calculated yield of oil from the heartwood would be 12 per cent.

In order to determine the rate at which the oil distilled over and thereby to ascertain the point beyond which it would be uneconomical to continue the steam distillation, sample No. 1 in the form of fine sawdust was fractionally steam-distilled. The results of this trial, with the constants of the four fractions obtained, are given in the following table, in comparison with the constants of the entire oil obtained in the previous distillation of this sample of wood (see page 245).

—	1st Fraction (A)	2nd Fraction (B)	3rd Fraction (C)	4th Fraction (D)	Total
Yield of oil *per cent*	6·2	2·8	2·8	1·1	12·9
Proportion of total oil *per cent*	48·1	21·7	21·7	8·5	100
Gallons of aqueous distillate:					
Per lb of wood distilled . . .	1·34	1·55	4·4	5·03	12·32
Per lb. of oil obtained	22	55	157	457	96

Constants of oils.

—	A	B	C.	D	Entire oil from previous distillation.
Specific gravity at 15·5/15·5° C .	0·9596	0·9643	0·9691	0·9600	0·9679
Optical rotation α_D .	− 31·23° at 20° C	− 27·85° at 20° C.	− 25·71° at 20° C	− 32·41° at 21° C.	− 24·95 at 21° C.°
Refractive index, n_D 20° C. . .	1·5078	1·5096	1·5110	1·5100	1·5100
Acid value . .	2·2	4·5	10·9	18·3	6·1
Ester value . .	15·1	16·0	14·8	10·1	20·8
Ester value after acetylation. . .	56·5	66·0	74·0	58·7	76·7
Solubility in 90 per cent alcohol at 15·5° C.	[1] Soluble in 6·5 vols.	[1] Soluble in 0·6 vol No turbidity on further dilution.	Soluble in 0·4 vol No turbidity on further dilution.	Soluble in 6·9 vols.	Soluble in 0·5 vol. No turbidity on further dilution.

---

[1] *A mixture of fractions A and B in the proportions in which they were yielded by the wood, i e* 6·2 *parts of A and* 2·8 *of B, was soluble in* 0·8 *vol. of* 90 *per cent. alcohol.*

Finally, to determine whether either chips or shavings would be suitable for the production of the oil, chips of sample No. 1, measuring about 1¼ × 1 × ⅛ in., and small thin shavings of this sample obtained with a spindle-planing machine, were separately steam-distilled, and two fractions separated in each case ; the amount of aqueous distillate collected being equivalent to that collected in fractions A, B and C on the steam distillation of the sawdust. The results obtained are shown below, in comparison with those previously obtained in the distillation of the sawdust :

	Yield of oil, per cent		
	Chips	Shavings	Sawdust
1st Fraction (2·9 gallons of distillate per lb. of wood)	1·8	4·3	9·0
2nd Fraction (additional 4·4 gallons of distillate per lb. of wood)	0·6	1·6	2·8
Total of the two fractions (7·3 gallons of distillate per lb. of wood)	2·4	5·9	11·8

These figures show that the oil was much more readily expelled from ground wood than from chips or shavings. The chips, in particular, yielded up the oil very slowly. A more satisfactory yield was obtained from the shavings, but the total yield of 5·9 per cent. quoted above necessitated the collection of 7·3 gallons of aqueous distillate per lb. of wood, as compared with only 2·9 gallons per lb. of wood for a yield of 9 per cent. of oil in the case of the ground wood.

The various oils obtained on distilling the samples were submitted to a firm of essential oil distillers who had estimated the value of the previous sample at about 4*s*. per lb. for limited quantities (see page 243). They stated that it would not be possible to investigate further the question of the value of the oil until it had been subjected to a thorough examination, for which a quantity would be required sufficient to enable the firm to submit samples to their customers. For this purpose they suggested that about 2 tons of the heartwood should be sent to them, for distillation at their works by their own methods, as they would then be better able to judge the value of the oil.

It was pointed out to the firm that in actual practice it would be proposed to distil the waste wood in Nyasaland, but they nevertheless considered that there might be a possibility of exporting the waste for distillation in the United Kingdom. It would, however, be necessary in this case to remove the sapwood before shipment. The firm stated in this connection that they would be glad to receive an estimate of the amount of waste wood likely to be available annually for distillation.

The oils distilled from Samples Nos. 1 and 3 were also submitted to two firms of merchants and importers, who furnished the following observations :

(*a*) " We have now carefully examined the two samples which you kindly sent us, and do not feel we can speak very definitely on the commercial value of the Mlanje cedar as a source of cedar-wood oil without a very much larger sample which could be tried out by manufacturers.

" We are quite certain, however, that Sample No. 3 has no commercial value owing to its insolubility. No. 1, on the other hand, has the two merits of high ester value and good solubility, like the Kenya cedar-wood oil, but its odour is disappointing. Tried out on papers the odour of this oil is definitely unpleasant, but tends to improve as time goes on. It is for this reason that we are reluctant to condemn it altogether as a commercial proposition until we have had an opportunity of seeing what results can be obtained by using it in soap. We are, however, not very hopeful of there being a market for it, and in any case, in spite of its good solubility, its value would be less than that of the American cedar-wood oil, which is to-day quoted on this market at about 1*s.* 4*d.* per lb." (December 1933).

(*b*) " The samples are not sufficiently large to enable us to put them to a practical test, but we have compared the samples with cedar wood we are receiving direct from distillery plants in Kenya Colony, and we find that although there is a marked difference in the odour and appearance of the two samples you sent us, neither of them compares at all favourably with the Kenya oil.

" Sample No. 1 has very little, if any, of the characteristic odour of cedar wood, and we do not think that it would be of any use for perfumery purposes.

" Sample No. 3 has some odour value, but only slight compared with the Kenya oil or American oil. The odour is also different and we are of the opinion that it would not find a market here in its present form."

The examination of the present samples of Mlanje cedar wood shows that the oil is mainly confined to the heartwood, so that the yield varies according to the amounts of heartwood and sapwood present.

The oils obtained from Samples Nos. 1 and 2 were similar in odour to that distilled from the previous sample of wood, and the constants of the three oils showed no outstanding differences.

The oil obtained from Sample No. 3 possessed a rather stronger odour of cedar wood than those from the other samples. It will be observed that this oil gave the lowest figure for the ester value after acetylation, indicating that it contained the least amount of alcohols, which would account for its lower solubility.

Sample No. 4 yielded oil containing a higher percentage of alcohols, which rendered its solubility very satisfactory. The odour of this oil was, however, not quite so agreeable as that of the others.

The results of the fractional steam distillation of the present sample No. 1 show that about 85 per cent. of the oil was expelled fairly readily, and that the operation then slowed down very considerably, with the result that the remaining oil was obtained only by greatly prolonging the time of the distillation, thus necessitating the collection of a relatively large volume of aqueous distillate. By the employment of high-pressure steam it would, however, be possible to reduce the period of distillation owing to the more ready expulsion of the oil. From the examination of the last fraction of the oil it appears unlikely that its inclusion would have any material effect on the quality of the oil or increase its market value.

It is interesting to note in this connection that the solubility of the oil increased up to a certain point as the distillation proceeded, and then fell, fraction D being less soluble than the first fraction A. A mixture of fractions A and B in the proportions in which they were yielded by the wood was found to be soluble in 0·8 volume of 90 per cent. alcohol.

The constants of fraction D indicate that the prolonged distillation had led to some decomposition of the oil, the acid value of this fraction being appreciably increased and the lower ester and alcohol content rendering the oil less soluble.

Judging from the results of the present fractionation experiments it should prove more economical to shorten the time of distillation, and thus increase the quantity of material which could be dealt with in a given time, than to attempt the complete removal of the oil.

The distillation experiments were conducted in the 10-gallon still mentioned in the previous report (page 241). The sawdust was kept in continual agitation during the distillation by means of a mechanical stirrer, and the steam was passed in from an outside boiler. In the case of the chips and shavings a mechanical stirrer was not employed.

Unless the still employed is provided with some mechanical stirring device to ensure agitation during distillation, the material when in a fine state of division is liable to form a solid mass through which the steam will not penetrate evenly, but will produce channels, so that the distillation is very incomplete. As previously mentioned, the most efficient type of still to employ is one constructed to withstand steam at high pressure. By using steam at high pressure more thorough penetration of the wood is rendered possible without the necessity of its being in so fine a state of division ; and at the same time there is a smaller quantity of vapour to be condensed. Owing, however, to the increased expenditure involved and the necessity of employing a skilled operator, the use of pressure stills in Nyasaland at this stage does not seem advisable. More simply constructed stills of the type mentioned above would prove quite satisfactory for the distillation of sawdust, though rather lower yields would probably be obtained from shavings.

OIL OF *ZANTHOXYLUM* SP. FROM KENYA

A sample of oil, stated to have been distilled in the Kericho District of Kenya from the leaves of a species of *Zanthoxylum* (near *Z. macrophyllum*, Nat. Ord. Rutaceæ) known locally as "sagawoita" or "satin wood" was forwarded by the Senior Agricultural Chemist in October 1933.

The sample consisted of a clear, brownish-yellow oil, with a rather pleasant odour. It was found to have the following constants:

Specific gravity at 15·5°/15·5° C	0·8715
Optical rotation α_D	−6·50° at 15° C
Refractive index n_D 20° C	1·4589
Acid value	3·2
Ester value	16·1
Solubility in 80 per cent alcohol at 15·5° C	Soluble in 1·2 vols with very slight opalescence, becoming turbid with more than 2 vols

The odour of the oil was suggestive of methyl-*n*-heptyl ketone or methyl-*n*-nonyl ketone, the chief constituents of oil of rue; and also of linalool, which was probably present. The ketone was isolated by means of its bisulphite compound, and its identity established by the preparation of the semicarbazone, which melted at 123°–124° C., i.e. the melting-point of methyl-*n*-nonyl ketone semicarbazone. The quantity of oil available was not sufficient for systematic chemical examination, but, by the hydroxylamine method, 53·4 per cent. of the ketone was shown to be present.

Oils from the leaves, seeds or fruits of a number of species of Zanthoxylum have been examined by different investigators and found to vary greatly in composition. Two of these, viz. the oil from the leaves of the Japanese species *Z. ailanthoides*, and that from the husks of the fruit of the African species *Z. senegalense*, contain methyl-*n*-nonyl ketone, and in the latter oil the presence of linalool also was detected. The recorded constants of these two oils, however, are different from those of the present sample from Kenya.

The oil was submitted to (*a*) importers and (*b*) essential oil distillers in London, who furnished the following reports respectively :

(*a*) " It is difficult to express a definite opinion on such a small sample, but judged by its odour we see no likelihood of the oil being of any interest in the soap or perfumery trades, and we think it extremely doubtful whether a market could be found for the oil should it be produced on a commercial scale."

(*b*) " We have very carefully examined the sample of Zanthoxylum oil from Kenya and have to report that in our opinion it might find a limited use in compounding perfumes of the Neroli type. The active principle, methyl-*n*-nonyl ketone, is not very widely used, and it is as well to bear in mind that it can easily be produced synthetically.

" As you can imagine it is very difficult to put a value on the oil for commercial purposes, but as some guide we could suggest a figure of 10s. per lb." (May 1934).

The difference of opinion expressed by the two firms as to the possible value of this Zanthoxylum oil is not unusual in the case of a small sample of a new oil. In any event, the demand for the oil is likely to be limited, and it may prove inadvisable to undertake its production on a commercial scale. It was pointed out to the Kenya authorities, however, that it would be desirable to carry out a further examination of the oil and conduct practical trials before coming to any decision on this point. It has been suggested that a larger sample of 2 to 3 lb. of the oil should be furnished for this purpose.

ARTICLE

SOME EAST AFRICAN ESSENTIAL OILS

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Introduction

This paper contains the results of investigations by the author on essential oil-bearing plants, indigenous and cultivated, growing in or around Amani. Amani itself is situated at an altitude of 3,000 ft. in the Usambara mountains, with an average annual rainfall of about 80 in.

A casual inspection shows that there are very many plants indigenous to these parts which contain more or less essential oil, and only a comparatively small number have been examined, mainly those which showed some promise of value and were not too difficult to collect.

The still that has been employed for nearly all the work was made locally by the author and is of 10 gallons capacity, being designed for passing in steam for a steam distillation or for heating directly with gas at the bottom. This still was made from a 10-gallon oil drum and has been found satisfactory in every way. When only small quantities of material were available ordinary laboratory glassware was employed.

All physical measurements such as specific gravity, refractive index and optical rotation are recorded for 20° C., unless otherwise stated.

Many of the figures quoted for comparison have been taken from *The Chemistry of Essential Oils and Artificial Perfumes*, by E. J. Parry (4th edition).

I. *AFRAMOMUM SPP.* (Zingiberaceæ)

From a scientific point of view, two species of this genus, which grow wild around Amani, are the most interesting essential oil-bearing plants examined by the author. They are *A. mala* K. Schum. and *A. amaniense* Loes. The plants are very similar in appearance to the cardamom

(*Elettaria Cardamomum*), the flowers occurring on spikes at the base of the plants, but the fruits are considerably larger than those of the cardamom.

A description of the fruits and seeds is given, since those of *A. amaniense* do not appear to have been described previously, whilst those of *A. mala* are only recorded in very brief detail. The two fruits are very similar in appearance and were originally collected by the author as one species, the difference not being discovered until the seeds were examined. After examining the two fruits, however, it is easy to differentiate between them.

A. mala.—A plant with leaves from 18 to 24 in. long and 4 to 5 in. broad in the middle ; glabrous on both sides. Flowers 3 to 3½ in. long and golden yellow.

The fruit is fusiform, green when unripe and bright red when ripe. It is 2¼ to 2½ in. long and ¾ to 1 in. diameter, with 11 to 13 slight grooves around it in the direction of its length ; the surface is slightly roughened in appearance. The fruit does not split open readily when squeezed at the base.

The seeds are contained in three segments and number about 100 to 150 per fruit. They are dark brown, very shining, ovoid, ⅛ in. long and $\frac{1}{10}$ in. in diameter ; on drying they retain their shape and appearance.

A. amaniense.—A plant with leaves from 8 to 12 in. long and 1½ to 2½ in. wide ; upper surface glabrous, under surface finely pubescent. Flowers 3 to 3½ in. long and bright violet.

The fruit is ampulliform, green when unripe and bright red when ripe. It has a smooth glabrous surface with three marked ridges corresponding to the three segments of the inside. It is 2½ to 2¾ in. long and 1 to 1¼ in. diameter. When squeezed at the base the fruit splits easily. The seeds are lightish brown, slightly shining and angled : they are ⅙ in. long and $\frac{3}{20}$ in. wide, and on drying they shrivel and become non-shining. See Plate 1.

Different essential oils are obtained from the leaves, seeds and fruit peel of both varieties : the two oils from the leaves contain similar constituents but varying in their proportions ; the two from the peels are different from the leaf oils, but again are similar to one another, whilst the

PLATE I.

FRUITS AND SEEDS OF *Aframomum* SPP.

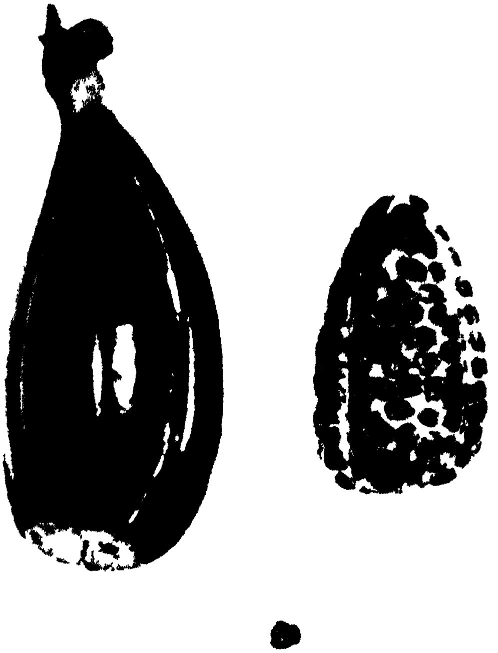

FIG. 1. *A. amaniense.*

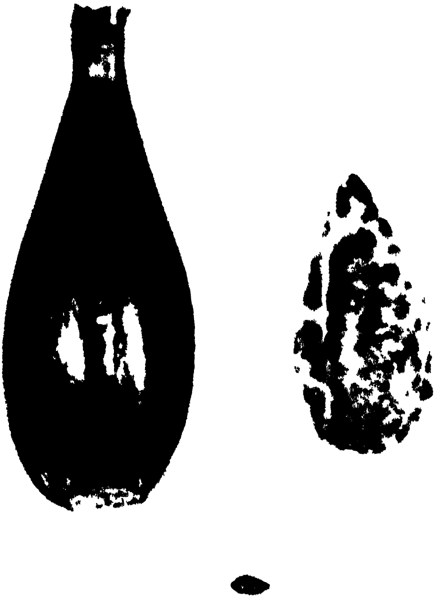

FIG. 2. *A. mala.*

two from the seeds are different from any of the above and entirely different from each other.

In Table 1 are shown the properties of these oils.

TABLE 1

PROPERTIES OF AFRAMOMUM OIL

—	*A amaniense.*			*A mala*		
	Leaf	*Peel*	*Seed*	*Leaf*	*Peel*	*Seed*
Yield . *per cent*	0·03	0·0075	0·82	0·05	0·13	3·42
Specific gravity .	0·8935	0·892	0·8971	0·8695	0·8603	0·8810
Refractive index .	1·4879	1·4835	1·4743	1·4781	1·4712	1·4693
Optical rotation α_D	−6·7°	—	−4·5°	−8·7°	+10·8°	−10·9°
Acid value . .	0·8	0·4	0·5	1·5	0·2	0·2
Ester value . .	7·5	4·3	100·9	10·5	6·0	3·4
do after acetylation	31·9	—	241·1	35·6	54·2	31·1
Bisulphite-soluble, *per cent*	nil	0·3	0·8	1·0	0·4	2·8
Hydrocarbons, *per cent*	75·0	—	0·5	77·0	—	67·0

(*a*) *Aframomum leaf oils*

Both oils contain appreciable quantities of caryophyllene and their odours are principally governed by this constituent. Being very similar in constitution they are considered together. The chief difference in physical properties is that the oil from *A. amaniense* has a higher density and refractive index than that from *A. mala*; this is due, as is shown below, to a higher percentage of caryophyllene.

Both oils were fractionated under reduced pressure and the results are shown in Tables 2 and 3.

TABLE 2

FRACTIONATION OF *A amaniense* LEAF OIL

Fraction	Pressure	Temperature	Volume		Refractive Index	Specific Gravity
	mm	° *C.*	*c c.*	*per cent*		
A	10	45– 47	1·5	6·2	1·4734	0·869
B	10	50– 55	2·2	9·2	1·4747	0·856
C	10	55– 60	1·8	7·5	1·4759	0·851
D	10	60– 70	4·0	16·7	1·4770	0·852
E	10	80–100	2·7	11·2	1·4819	0·882
F	10	100–110	1·4	5·8	1·4898	0·898
G	10	115–120	6·0	25·0	1·4966	0·907
H	12	124–126	2·9	12·1	1·4990	0·915
I	12	Residue	1·5	6·3	1·5188	—

TABLE 3

FRACTIONATION OF *A. mala* LEAF OIL

Fraction	Pressure	Temperature	Volume		Refractive Index	Specific Gravity
	mm	°C	cc	per cent		
J	10	45– 47	1·6	5·3	1·4704	0·861
K	10	54– 64	15·2	50·7	1·4715	0·853
L	10	65– 75	2·4	8·0	1·4752	0·863
M	10	110–120	6·3	21·0	1·4915	0·898
N	10	120–130	3·2	10·6	1·4981	0·909
O	10	Residue	1·0	3·3	—	—

An inspection of these figures shows the similarity between the two oils. The residues are mostly sesquiterpenes with some oxygenated compounds, probably formed during the distillations.

Fractions F, G and H were mixed and redistilled and gave 37·1 per cent. (of the original oil) as one fraction between 115° and 120° C. at 10 mm. pressure : this fraction had a refractive index of 1·4978 and a density of 0·908. Fractions M and N on redistilling yielded 24·6 per cent. as one fraction between the same temperature range and with a refractive index of 1·4970 and specific gravity of 0·902. Both these fractions proved on examination to be caryophyllene, a mixture as far as could be ascertained of the two forms and in roughly equal proportions.

By far the most interesting fraction in these oils is Fraction K (and Fractions B + C + D which later proved to be the same as K). This fraction is a hydrocarbon possessing physical properties not in agreement with any known terpene or sesquiterpene ; in addition it does not give crystalline halogen, halogen acid, nitroso- or nitrosite derivatives. There is no doubt that it is a new hydrocarbon, not previously reported in any oil. On redistillation Fraction K gave 40 per cent. of an oil boiling at 43° to 46° C. at 7 mm. pressure, with a refractive index of 1·4717 and specific gravity of 0·8511, and 10 per cent. boiling at 48 to 51° C. with a refractive index of 1·4732 and specific gravity of 0·8531. Molecular weight determinations shows both these fractions to be about 220.

Owing to the small amounts available further work could not be carried out, but it was later shown that Fraction K occurs to an extent of about 37 per cent. in *A.*

mala seed oil, which is obtainable in much larger quantities; further discussion of this fraction is, therefore, left over until the seed oil is dealt with.

Fractions E and L could not be identified, but were mainly hydrocarbons, and fractions J and A proved to be mainly β-pinene.

The approximate constitution of the two oils is shown in Table 4.

TABLE 4

	A mala *per cent*	*A amaniense* *per cent*
Caryophyllene . .	24 6	37 1
-Pinene . .	5 3	6 2
" Fraction K " .	50 0	33 0
" Rest " .	20 1	23 7

Samples of these two oils were submitted to a perfumery firm and were stated to be of only little commercial value. If the oils from other parts of the plants proved of value the distillation of the leaves might be undertaken as a side line.

(*b*) *Aframomum seed oils*

The oils obtained from the two varieties of seed are so different in character that they must be considered separately.

A. amaniense seed oil.—The yield of oil from the air-dried seed is about 0·82 per cent.; from the fresh seed and pulp, obtained simply by removing the peel, the yield is about 0·49 per cent. The constitution of the oil varies slightly at different times of the year, but distillation of the dried seed or of the freshly peeled fruit produces the same oil at any one time.

Distillation of the whole peeled fruit is somewhat slow, six hours being necessary: possibly a higher steam pressure than the author could obtain (1½ to 2 atmospheres), would speed it up. On the other hand if the dried seed be crushed (not ground) so as to split the shell, distillation is complete in half an hour. It is a colourless, pleasant-smelling oil, resembling that of rose-geranium. Distilled under reduced pressure it gave the following fractions (at 40 mm.):

TABLE 5

Fraction	Temperature °C	Volume per cent	Refractive Index.	Specific Gravity.
P	Up to 140	3·0	1·4627	0·868
Q	140 to 150	52·0	1·4721	0·894
R	150 to 155	32·0	1·4737	0·910
S	155 to 160	6·0	1·4743	0·901
T	Residue	6·0	1·4937	0·922

Fraction Q on purification proved to be almost entirely geraniol, and Fraction R geranyl acetate. Fraction P is probably the same as the new hydrocarbon isolated from the leaf oil (Fraction K), but the small amount available was not sufficient to settle this point definitely. Fractions S and T could not be identified.

Determinations of the ester values before and after acetylation gave 100·9 and 241·1, equivalent to 35·3 per cent. geranyl acetate and 4·70 per cent. geraniol: these figures agree with the results of the fractionation.

A sample of one of the earlier distillations of this oil was submitted to the Imperial Institute under the name of a "natural geraniol" oil for examination. They reported that apart from slight differences in optical rotation and refractive index the constants of the present oil agree well with those of commercial geranium oils (Algerian and Bourbon), and the oil contains a high percentage of total alcohols calculated as geraniol." Essential oil distillers to whom it was submitted did not consider the odour comparable to that of geranium oils and valued it at a considerably lower figure.[1]

A further sample has been prepared by an improved method of distillation and the odour seems to be better. It was submitted to two perfumery firms, both of which valued it below geranium oil, the one at about 10*s*. per lb. and the other at about 4*s*. 6*d*. per lb. It was stated that it would find a ready sale with the manufacturers of synthetic perfumes at the lower value, 4*s*. 6*d*. At this value it is very doubtful if the distillation of this oil would be a profitable concern owing to the difficulty of cultivating the plant, but this question will be further looked into.

A. mala seed oil.—This oil can likewise be obtained by distillation of the crushed, air-dried seed or of the freshly-peeled fruit. The yield in the former case varies between 3·2 and 3·4 per cent. and in the latter case is about 1·5 per cent.

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[1] The full report on the examination of this oil at the Imperial Institute will be found on p. 228 of this BULLETIN.

The oil smells strongly of cineole and is of a thin water-white appearance. Fractionated at 6 mm. pressure it gave the following :

TABLE 6

Fraction	Temperature °C	Volume Per cent	Refractive Index	Specific Gravity
U	Up to 50	0·3	1 4671	—
V	50 to 60	78 7	1 4665	0 886
W	65 to 70	4·3	1 4670	0 889
X	Above 70	16 7	1 4902	—

Fractions U and X smelt only faintly of cineole, but V and W strongly of it. Repeated fractionation failed to split up V and W into different constituents. It was obvious from the density that they were far from being pure cineole and rough determinations showed them to be about half cineole. Finally chemical methods had to be used for the separation. The most suitable method found was to shake the fraction with excess of a saturated solution of resorcinol ; the solid cineole-resorcinol compound was formed and was filtered off on a Buchner funnel ; the residual oil was then twice shaken with nearly saturated resorcinol solution, any further crystals formed being filtered off, and the oil separated in a large separating funnel. It was then washed twice with warm water and finally four or five times with a large excess (about 20 times) of 51 per cent. alcohol at room temperature. By this means all traces of cineole were removed.

The residual oil, equal to 37·3 per cent. of the original oil, was found to be the same as Fraction K from the leaf oil. After a large number of tests had been made on this Fraction K it became obvious that it was a new hydrocarbon, and the author, having become used to calling it Fraction K during the investigation, proposes to name it " kayene."

By careful repeated fractionation at low pressures, over sodium and in a current of hydrogen, kayene can be split up into two fractions, which have been named α- and β-kayene. That these two fractions are only modifications of the same compound is obvious from their properties.

Various determinations point to kayene having the formula $C_{16}H_{28}$. Thus, vapour density determinations gave a value of 220, which is that required by $C_{16}H_{28}$; combustion gave 87·21 per cent. of carbon and 12·71 per cent. of hydrogen, $C_{16}H_{28}$ requiring 87·27 per cent. of carbon and 12·73 per cent. of hydrogen. The determination of unsaturation by the bromine method, besides indicating the presence of two ethylene linkages, showed (as the result of four determinations) the molecular weight to be between 216 and 224.

The physical properties of the most carefully purified samples were as follows :

TABLE 7

	α-Kayene	*β Kayene*
Boiling point (8 mm) .	33·5° to 34·5° C.	44·5° to 45·5° C.
Specific gravity . .	0·8600	0·8591
Refractive index . .	1·4713	1·4721
Optical rotation α_D .	−7·9°	−15·1°
Molecular refraction .	71·55	71·70
do. do. for $C_{16}H_{28}$.	69 33	69·33

From the molecular refractions it would appear that α-kayene contains one double bond and one cyclobutane ring, this requiring a value of 71·54, the determined value being 71·55 ; and that β-kayene contains one double bond and one cyclopropane ring, requiring a value of 71·74, as against 71·70 found. The low density, 0·86, would indicate a long side chain.

Both kayenes yield only liquid hydrochlorides and bromides ; in ice the chief products are the monohydrochloride and the dibromide. In the warm, tri-halogen compounds are formed, due as far as can be ascertained to the formation of tetra-compounds and the subsequent elimination of HCl or HBr, with the probable closing of the ring in the side chain.

Oxidation yields an acid of the formula $C_8H_{17}COOH$, similar to, but not identical with, pelargonic acid.

Further work on the constitution of kayene is in progress.

Further fractionation of Fraction U showed it to contain 0·9 per cent. β-pinene, 1·6 per cent. cineole and 10·2 per cent. kayene. Fraction X on further fractionation gave (at 2 mm. pressure):

TABLE 8

Fraction.	Temperature °C	Volume. Per cent	Refractive Index.	Specific Gravity
X1	Up to 60	2·7	1·4667	0·889
X2	60 to 75	1·0	1·4706	0·903
X3	80 to 85	2·8	1·4809	0·917
X4	85 to 90	3·6	1·4861	0·919
X5	90 to 100	1·8	1·4951	0·899
X6	101 to 102·5	2·3	1·4984	0·892
X7	Residue	0·8	—	—

Fraction X1 proved to be half cineole and half kayene, X2 could not be identified, X3 and X4 were mostly terpineol, and X5 and X6 mostly caryophyllene, giving a blue nitrosite with a melting point of 116° C. The composition of *A. mala* seed oil is thus approximately as follows:

	Per cent
Cineole	41·5
Kayene	37·3
Terpineol.	6·4
Caryophyllene	4·1
β-Pinene	0·9

A sample submitted to a perfumery firm was stated to have no commercial value owing to the high cineole content; this, of course, is only what was expected.

Aframomum Peel Oils

The fresh peel of *A. amaniense* yields 0·0075 per cent. of oil, whilst that of *A. mala* gives 0·13 per cent. If allowed to dry and wither no oil is obtainable.

Insufficient of the former oil was obtained for more than a few physical tests, but these together with its odour show it to be very similar to the *A. mala* oil.

200 cc. of *A. mala* peel oil on fractionation at 4·5 mm. pressure gave the following fractions:

TABLE 9

Fraction	Temperature	Volume		Refractive Index	Specific Gravity
	°C	cc	Per cent		
1	40–48	159·0	79·5	1·4697	0·8483
2	52–62	10·0	5·0	1·4703	0·8559
3	67–80	8·0	4·0	1·4734	0·8773
4	87–90	7·0	3·5	1·4796	0·9014
5	Residue	14·0	7·0	1·4923	0·9202

Fraction 1 on careful distillation proved to be nearly pure kayene, being about 52 per cent. α-kayene and 21 per cent. β-kayene, expressed on the original oil. The other fractions, 3 to 5, on redistillation gave 4 per cent. of caryophyllene, 2·5 per cent. of an alcohol which is probably terpineol, and 13 per cent. unidentified. The constitution is therefore approximately :

	Per cent
Kayene	73
Caryophyllene	4
Terpineol	2·5
"Rest"	20·5

A. amaniense peel oil probably differs from the above oil by having a lower proportion of kayene and higher amounts of the heavier fractions.

The *A. mala* oil was stated by the perfumery expert to have only a low commercial value.

(*d*) *Aframomum Root Oils*

The roots of *A. amaniense* do not yield any oil : those of *A. mala* give 0·011 per cent. of a yellowish oil with a refractive index of 1·4887 and an odour unlike any of the other oils, but behind which is a smell very reminiscent of geranyl acetate ; only a very small quantity was obtained.

In Table 10 is shown the approximate composition of the various Aframomum oils and it will be seen that they are all very similar with the exception of the *A. amaniense* seed oil, which is entirely different, and *A. mala* seed oil, which contains cineole.

TABLE 10

Constituent	*A mala*			*A amaniense*		
	Leaf	*Peel*	*Seed*	*Leaf*	*Peel*	*Seed*
	Per cent	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*
Kayene . .	50·0	73·0	37·3	33·0	50·0[1]	2·2
Caryophyllene .	24·6	4·0	4·1	37·1	10·0[1]	—
β-Pinene	5·3	—	0·9	6·2	—	—
Terpineol . .	—	2·5	6·4	—	25·0[1]	—
Cineole . .	—	—	41·5	—	—	—
Geraniol .	—	—	—	—	—	47·0
Geranyl acetate .	—	—	—	—	—	35·3

[1] *Calculated from the physical constants.*

These values would suggest that the caryophyllene present in the leaves is converted to kayene in the peel and that this kayene is, in the seeds, converted in the one case to geraniol and its acetate and in the other case partly to cineole. It is expected that these facts will assist in the elucidation of the constitution of kayene.

II. GRASS OILS (Gramineæ)

(*a*) *Cymbopogon citratus or Lemongrass*

This grass grows very prolifically in and around Amani and it is possible to obtain 7 or 8 cuttings a year from it. The yield varies from 0·25 per cent. for freshly-cut grass to 0·44 per cent. for grass which has been air-dried for 7 days.

A sample of the grass grown from roots obtained from the Kenya Department of Agriculture gave a yield of 0·61 per cent. after 3 days of drying, compared with 0·27 per cent. for the Amani grass. It remains to be seen if it will grow as prolifically, since only 3 to 4 cuttings per year are obtained from it in Nairobi.

A sample from Kwamkembe, on the coast near Tanga, was also examined.

Table 11 gives the results obtained.

TABLE 11

		Amani grass	*Kenya grass*	*Kwamkembe grass*
Yield, 3 days dried	*per cent.*	0·27	0·61	0·25
Specific gravity		0·8949	0·8962	0·8928
Refractive index		1·4854	1·4821	1·4842
Optical rotation α_D		+0·4°	+0·3°	0·0
Citral (bisulphite)	*per cent.*	75·5	73·6	84·0

It will be noticed that the citral content is good in each case, whilst in the Kwamkembe oil it is very high.

A portion of the Amani oil on fractionating gave 73·5 per cent. of citral, having a specific gravity of 0·8941 and a refractive index of 1·4844.

About 1½ tons was distilled in an old still capable of holding a charge of about a hundredweight at a time. A total of 9¼ lb. of oil was obtained, and this was shipped to England for sale. The result was slightly disappointing: the large still was not as efficient as the laboratory one and the citral content fell to 69 per cent. At the same time the brokers described the odour as flat and smelling of the tin in which it was shipped.

Two samples of the same oil kept in stoppered glass bottles were submitted to perfumery experts and both were described as of good odour and up to the usual market standards.

Further work on this grass is being carried out.

(*b*) *Cymbopogon Martini*

This grass was grown in Amani from seed obtained from Zanzibar. It was reputed to be pure palmarosa grass, but the seed produced a grass which smelt of gingergrass and yielded an oil which although not entirely gingergrass oil was very nearly so.

The freshly-cut grass gave a yield of 0·26 per cent. of oil having a specific gravity of 0·9261 and a refractive index of 1·4875. Table 12 shows its properties compared with those of palmarosa and gingergrass oils.

TABLE 12

	Present Oil	*Palmarosa Oil*	*Gingergrass Oil*
Specific gravity . .	0 9261	0 886 to 0 899	0 900 to 0 955
Refractive index . .	1·4875	1 472 to 1·478	1·478 to 1 495
Optical rotation α_D . .	−9 9°	−3° to +5°	−30° to +50°
Ester value . .	11·5	12 to 50	8 to 40
do, after acetylation	201	234 to 272	120 to 200

The figures show that the grass has reverted, to a considerable extent, to gingergrass.

A supply of pure palmarosa grass seed has been obtained from Kenya and is now being grown.

(*c*) *Vetiveria zizanioides*

The roots of this grass yield the oil of vetiver. The grass grows well in Amani and requires little attention.

The distillation of the roots is a matter of some difficulty, since a fairly high temperature is required. A yield of 0·84 per cent. was obtained, the oil having the following properties:

TABLE 13

	Present Oil	*Usual Value*
Specific gravity . . .	1·017	1 014 to 1 042
Refractive index . .	1·5118	1 520 to 1·523
Optical rotation α_D .	+29·5°	+25° to +40°
Acid value . . .	17·4	25 to 65
Ester value . . .	12 2	10 to 25
do, after acetylation .	135	130 to 160

These figures show that it compares fairly favourably with European distilled oils. There would not, however, be much likelihood of it finding a ready market.

(*d*) *Melinis minutiflora*

This is a grass with a strong and unpleasant smell. It is reputed to be repellent to Tsetse fly and for this reason an attempt was made to obtain an essential oil from it. Neither distillations nor extractions with solvents, however, produced more than a mere trace of oil.

III. GERANIUM OILS (Geraniaceæ)

Three varieties of Pelargonium were in cultivation in Amani for distribution to planters and it was decided to examine these so as to ascertain their relative values for oil production. The first variety, *Pelargonium graveolens* var., yielded so little oil, namely 0·02 per cent., that it was discarded.

The other two, *P. capitatum* and *P. capitatum* var., yielding 0·21 per cent. and 0·26 per cent. respectively, were examined further. The second variety has much finer leaves than the former and had a distinct odour of peppermint in addition to the geranium smell.

It was found that 16 plants of the *P. capitatum* yielded 15½ kilos. of leaves which on distillation gave 31·9 g. of oil, or 2 g. per plant. At the same time 16 plants of *P. capitatum* var. yielded 9·1 kilos. of leaves, giving 24·1 g. of oil or 1·5 g. per plant.

Both varieties can be cut four or five times a year.

Oils from both were submitted to the Imperial Institute for examination and valuation. The Institute reported that both oils were inferior to Algerian and Bourbon geranium oils and that they differed somewhat from the

" Mawah " geranium oil from Kenya. The oil from *P. capitatum* var. was described as being an undesirable variety to cultivate. It was suggested that the other variety should be gathered and kept for 24 hours before distillation, as is done in Réunion ; this was carried out and the oil was examined by the author. Table 14 shows the results obtained, the values in Columns 1 and 2 having been determined by the Imperial Institute.

TABLE 14

—	*P capitatum* var	*P capitatum*	*P capitatum* after 24 hrs	Algerian oil	Kenya oil
Specific gravity .	0 8880	0 8948	0 8952	0 892 to 0 904	0 892
Refractive index .	1 4578	1 4705	1 4695	1 465 to 1 472	1 470
Optical rotation α_D	−30 7°	−8 95°	−9 7°	−7° to −11 5°	−18 5°
Acid value . .	7 9	15 2	8 1	1 5 to 10	5 8
Ester value .	12 4	13 2	15 1	40 to 70	22 0
Solubility in 70 per cent alcohol .	1 9	1 8	1 8	2 5 to 3	1 8

The figures show that the oil obtained after keeping the leaves for 24 hours is better than the previous sample and more nearly approaches the Kenya " Mawah " oil ; the odour also showed improvement and was similar to " Mawah " oil. A perfumery expert valued this oil at about the same price as that from Kenya, remarking that, although the ester content was somewhat lower, it lacked the usual " nasty " odour common to the East African oils of this type.

IV. ORANGE OIL (Rutaceæ)

Large areas of the Usambara district of Tanganyika are covered with a variety of bitter orange. The actual variety has not yet been determined, but is known locally as Mashuza. Although not the same as the Seville orange, it nevertheless makes good marmalade of the Seville type.

These oranges were cultivated over large areas by the former German colonists with a view to using the juice for the coagulation of rubber latex. The rubber industry proved a failure, but large areas of the oranges still exist, the fruit falling to the ground and being left to rot.

The oil was extracted in écuelling pans and from 200 oranges 35·7 g. was obtained. The oil was of a palish yellow colour and had a specific gravity of 0·853, refractive index of 1·4743 and an optical rotation of 91·3°. The non-volatile residue amounted to 4·2 per cent. The production of this oil has now been taken up by the Tanganyika Department of Agriculture and the author has, therefore, not carried out any further work on it.

V. *OCOTEA USAMBARENSIS* (Lauraceæ)

This tree, known as the Ibean camphor tree, is stated to be closely allied to *Cinnamomum Camphora*, the true camphor tree. The tree is a fairly common one in the forests around Amani and grows to a great height ; the bark, wood and twigs of the tree have a camphoraceous smell.

A quantity of the bark was distilled and yielded 0·37 per cent. of a thin, pale yellow oil with the following properties, shown in Table 15, together with figures for a similar oil distilled by Schmidt and Weilinger (*Ber.*, 1906, **39**, 653).

TABLE 15

	Present Oil	*Previous Oil*
Specific gravity	0 9178	0 913
Refractive index	1 4770	1 4760
Optical rotation αD	−8 3°	−11 2°
Acid value	0 3	1 2
Ester value	13 9	12 5
do , after acetylation	127 2	16 1
Aldehydes	6 0	1 0

The perfumery firm to which it was submitted stated that they did not like the odour and that in their opinion the oil was of very little commercial value.

VI. *CANANGA ODORATA* (Anonaceæ)

The flowers of this tree yield Ylang-ylang oil. A number of these trees were planted by the former German colonists at Sigi, 3 miles from Amani ; the original trees are still there and flower well every year.

Forty-one kilos. of the fresh flowers were distilled and yielded 263 g. of first-grade oil, i.e. 0·64 per cent., and 131 g. of second-grade oil, i.e. 0·32 per cent. ; the two grades being obtained by changing the receiver after about two-thirds of the oil had come over, the amount being ascertained by a small preliminary trial.

The properties of these oils, together with figures obtained by Schimmel and Co. (*Semi-Annual Report*, Oct. 1911, p. 102), for oil distilled in Amani in 1911 and almost certainly from the same trees, and also for Manila oil, are shown in Table 16.

TABLE 16

—	Present Oils		Previous Amani Oil	Manila Oil	
	1st grade	2nd grade		1st grade	2nd grade
Specific gravity .	0·9384	0·9414	0·9329	0·911 to 0·958	0·896 to 0·942
Refractive index .	1·4855	1·4965	1·4845	1·4827 to 1·5060	1·4908 to 1·5202
Optical rotation α_D .	−15°	−33·5°	−17·1°	−27° to −50°	−27° to −84°
Acid value . .	0·3	0·2	1·1	—	—
Ester value .	147·3	141·3	136·3	90 to 138	42 to 94

These figures indicate that the first-grade oil is quite normal in its physical properties and unusually high in ester content. The second-grade oil is even higher in ester content for this grade. It is possible that considerably more first-grade oil could have been obtained with a corresponding reduction in the amount of second grade: the author, however, thought it better to err on the right side, being inexperienced in the distillation of this oil.

A perfumery firm reported that the two oils were equal to good Bourbon oils and that the first-grade oil could well have been increased in volume from 67 per cent. of the total oil to 78 per cent. The lower grade was valued at about 10*s.* per lb. and the higher grade at from 17*s.* 6*d.* to 25*s.* per lb. At these figures the distillation of this oil on a commercial scale would appear to be well worth consideration.

VII. *MICHELIA CHAMPACA* (Magnoliaceæ)

About four of these trees exist in Amani, the flowers having a strong and pleasant odour.

The flowers were gathered and distilled fresh, 15·27 kilos. giving 16·8 g. of oil, i.e. a yield of 0·11 per cent. The oil had the following properties compared with Manila oil:

TABLE 17

	Present Oil.	*Manila Oil*
Specific gravity . .	0·911	0·911 to 0·918
Refractive index .	1 4711	1·464 to 1·4688
Optical rotation α_D . .	+6 1°	—
Ester value . . .	34·5	124 to 146

The figures show that whilst agreeing fairly well in physical properties with Manila oil the ester value is, however, very low. There was not sufficient oil for further tests and the results so far obtained did not appear to warrant further work on these trees.

VIII. *LANTANA CAMARA* (Verbenaceæ)

This plant, introduced by the Germans, is now a common and prolific weed in the Amani district ; it has a strong and unpleasant smell. Attempts were made to obtain an essential oil from the leaves, but only very small yields could be obtained. The fresh leaves yielded 0·069 per cent., leaves dried for 3 days yielded 0·08 per cent., and leaves piled up and allowed to ferment for 24 hours yielded 0·073 per cent.

The objectionable odour of the plant is due to some very volatile constituent, as during the distillation a most offensive odour is produced, the condensed oil having only a faint smell of verbena. The oil has a specific gravity of 0·9187, a refractive index of 1·4942 and an optical rotation of + 9·1°. It contains citral, but insufficient oil was obtained to determine it quantitatively.

It was hoped that this plant would serve as a new source for citral, but the yield is far too low even for such a prolific weed.

IX. *CONOPHARYNGIA HOLSTII* (Apocynaceæ)

This tree, until recently named *Tabernæmontana,* is a common forest tree around Amani. It has large white strongly smelling flowers, reminiscent of Ylang-ylang in odour.

Although of such strong odour the flowers only yielded a very small amount of oil. Steam distillation gave from 0·008 to 0·01 per cent.

Maceration with petroleum ether yielded 0·06 per cent. In either case the oil is semi-solid and of an unpleasant scent.

Many of these very strongly but quite pleasantly scented flowering plants yield only small amounts of unpleasant smelling oils.

X. *CINCHONA SPP.* (Rubiaceæ)

The different kinds of Cinchona (consisting of *C. Ledgeriana*, *C. succirubra* and a Cinchona hybrid) all have very strongly scented flowers.

On steam distillation, the flowers yielded 0·006 per cent. of oil: on macerating with petroleum ether they yielded 0·80 per cent.; of this, however, 0·16 per cent. was wax, insoluble in alcohol, so that the yield of oil was 0·64 per cent.

Since the flowers are very small a very large number would be required to produce any quantity of oil. The oil obtained had a strong and somewhat unpleasant odour; diluted with alcohol it was more pleasant. It might be of use as a fixative.

In conclusion I wish to thank Mr. F. M. Rogers, Superintendent of Plantations in Amani, for his assistance in the collection of plant material and for his interest in the work.

RECENT RESEARCH ON EMPIRE PRODUCTS

A Record of Work conducted by Government Technical Departments Overseas

AGRICULTURE

SOILS

Nigeria.—In the report of the Chemical Section of the Department of Agriculture (Southern Provinces) for the half-year, July 1 to December 31, 1933, it is stated that work continues to be done on the residual effects of varying amounts of lime and limestone on one of the Experimental Farms in the Eastern Provinces.

On the farm at Ibadan sampling is being carried out to find out how far fertility is affected by maintenance of carbon and nitrogen contents.

Lately, a rapid soil survey of the Niger delta has been undertaken with special regard to the suitability of swamps to grow rice—as is done fairly extensively in Sierra Leone. These soils are characterised by high salinity and extremely low p_H, which is probably due to production of HCl from the association of mangrove roots and sodium chloride. In addition to chlorides, sulphates are also present and ferrous iron salts in considerable amounts.

As opportunity offers, the more or less routine work of the soil survey is continued. Large tracts of country remain to be tapped and the difficulty here arises of getting satisfactory samples from out-of-the-way areas to which no Agricultural Officers penetrate.

A number of profiles have been taken from a tract of forest reserve land which is shortly to become an experimental cocoa farm. It is hoped that these may help in attacking the problem of " die back " in cocoa.

MANURES

Ceylon.—Dr. A. W. R. Joachim, in his report on the work of the Chemical Division, Department of Agriculture, for 1933, refers to work on the preparation of a compost manure from night soil and road refuse. As many as eighteen samples of compost manure from Nawala, Kurunegalle, Jaffna, Panadura, Kalutara and Anuradhapura were analysed during the year. The analyses indicate that a well-decomposed sample of sieved compost manure would contain, on the average, about 0·8 per cent. of nitrogen, 0·8 per cent. of phosphoric acid and 0·8 per cent. of potash on dry matter at 100° C., or about 0·5 per cent. of each of these constituents on material as received. An average sample of well-decomposed cattle manure contains about 0·6 per cent. of nitrogen, 0·4 per cent. of phosphoric acid and 0·5 per cent. of potash. Compost manure is therefore seen to compare very favourably with cattle manure. As a result of experiments carried out in cooperation with the Acting Sanitary Engineer at Nawala and the Medical Officer of Health, Kegalle, the following conclusions have been arrived at in regard to the various details of compost making: (1) samples of compost prepared from night soil alone, apart from being less decomposed, are poorer in nitrogen and organic matter than those prepared with night soil as starter; (2) the successive weekly charging of the refuse heaps with 5, 2½, 2½ and 2½ per cent. of night soil gives a much better compost than that obtained from a single charge of 12½ per cent. of night soil ; (3) no lime should be added to the heaps to hasten decomposition, as large losses of nitrogen and organic matter will thereby occur ; (4) the maximum decomposition of organic matter of a heap at Kegalle, kept under cover and turned over once a fortnight, was only 13·2 per cent. after two and half months, this being mainly because the original material had a large proportion of areca nut husk which is very resistant to decomposition ; (5) it is preferable, generally, to leave compost heaps uncovered ; (6) a weekly turning of the heaps is advisable. The investigations are being continued, and on their completion it is hoped to publish the results in co-operation with the Medical Department.

Dr. Joachim also gives a summary of the results of experiments carried out at the Experiment Station, Peradeniya, to determine : (1) the amounts of nitrogen fixed in the soil by the leguminous cover crop *Calopogonium mucunoides*, and (2) the effects of green manuring alone and in conjunction with artificial nitrogenous fertilisers. An examination of the data indicates that : (1) under local climatic conditions the effects of green manures on the carbon and nitrogen contents of the soil are not apparent at the end of a period of six months, although the green manures appear to have entirely decomposed by this time ; (2) highest percentages and amounts of dry matter and nitrogen are obtained from the plots manured with basic slag ; (3) there is no appreciable difference between the dry-matter yields of crop from the cyanamide and untreated *Calopogonium* plots, but the percentage of nitrogen in the former is slightly higher ; (4) all treatments without exception have registered net gains in nitrogen, chiefly as soil nitrogen, at the time the *Calopogonium* was harvested. The control plots have apparently benefited from their close proximity to those under the cover crop.

COVER CROPS

Ceylon.—The following notes on cover crops tried at the School Farm and Experiment Station, Peradeniya, are taken from the report of Mr. W. C. Lester-Smith, Officer-in-Charge, for the year 1933.

Parochetus communis.—This cover crop was tried during the year for a second time, a box of plants being kindly supplied by the Tea Research Institute. It was previously tried in 1930 and failed ; this year it was tried in a lighter, well-manured soil, under the shade of coconuts, but most of the plants have died out and it appears quite unsuited to this elevation.

Atylosia scarabæoides.—A small plot of this cover crop was planted in August with seed obtained from the Experiment Station, Wariyapola. It has made fairly good growth and had commenced flowering and setting seed in December.

Trifolium alexandrinum (Egyptian Clover or Berseem).—A plot of this clover was sown in July with seed obtained from Australia. It made excellent progress and grew to an average height of one foot and commenced flowering, but set no seed. It was cut down and came up again fairly satisfactorily, but with continued wet weather the plants were severely attacked and killed out in patches by *Sclerotium Rolfsii.*

Trifolium subterraneum (Subterranean Clover).—A small plot of this clover was planted in July with seed obtained from Australia. Up till November growth was good and the plants spread somewhat and had made about six inches of above-ground growth, but showed no indications of flowering. With the continued wet weather many of the plants were attacked by *Sclerotium Rolfsii.*

Trifolium hybridum (Alsike Clover).—A small plot of this clover was similarly planted in July with seed from Australia and made very promising growth, about four inches. It commenced flowering about the end of September, but in November it was affected by the continued wet weather and a number of plants were attacked by *Sclerotium Rolfsii.*

Trifolium pratense perenne (Perennial Red Clover).—This clover, sown in July from seed obtained from Australia, had grown to a height of 9 in. by November when a few of the plants were attacked by *Sclerotium Rolfsii.* It has shown indications of coming back into satisfactory growth after cutting and is distinctly the most promising of the various clovers under trial.

Trifolium repens (White Clover).—The growth of this clover has been uneven and distinctly patchy. It was sown in July with seed obtained from Australia and by September the best plants had made 2 in. of growth, but shown no indications of flowering. It did not appear to be attacked by the fungus disease which affected almost all the other clover plots. It was severely cropped by hares one night in November, but has regrown very satisfactorily.

Lotus corniculatus (Bird's Foot Trefoil).—This trefoil has made good growth and is a very promising plant. Seed was obtained from Australia and it was somewhat slow in starting to grow but subsequently came on remarkably well. Its growth where it has had room to spread is distinctly creeping and radiating from the central rootstock, with no indication of the shoots themselves tending to root. It had not shown any indications of flowering up to the end of the year, but a number of the plants have started dying off, possibly as a result of the wet weather.

Ipomœa pes-tigridis.—This was planted in August with cuttings from plants found on the Station. It has grown well but has shown no signs of proving a satisfactory cover crop and will be uprooted early.

Ipomœa alata.—This was planted in September with cuttings from plants found growing wild on the Station. It has a large leaf and succulent stems which root readily, and by the end of the year it had formed a thick cover to a depth of 1½ ft. It might prove to be a useful cover or smother crop under some circumstances, and could be readily removed. It has the disadvantage of not being a leguminous plant.

Passiflora fœtida.—This wild passion fruit, which has become naturalised in Ceylon, forms a very thick growth in three to four months from planting either from cuttings or seed. It was reported by Bamber in 1909 (*Circs. R.B.G.* IV, 16) to be used in the Federated Malay States for controlling illuk (*Imperata cylindrica*) and other troublesome wild grasses. It is proposed to make a trial of it next year for this purpose.

INSECT PESTS

Locusts

Nigeria.—Mr. F. D. Golding, Senior Entomologist, Department of Agriculture, in his report for the half-year, July 1 to December 31, 1933, states that during the period the results of the ecological survey carried out near Lake Chad in the first six months of 1933 were worked out in detail. The main conclusions were included in the report for six months ending on June 30, 1933 (this BULLETIN, 1933, **31**, 398).

Mr. A. M. Gwynn arrived at Kalkala on September 5 in order to continue the survey. The infestation of hoppers of the red locust, *Nomadacris septemfasciata* Serv., was on a smaller scale than in any of the preceding three years, but Mr. Gwynn found that the coloration of some of the hoppers approached that of the swarming phase. No swarms of adults were seen to migrate from the Chad region.

In late October, Mr. Gwynn collected about twenty adults of the desert locust, *Schistocerca gregaria* Forsk., which he believes had been carried across Chad by the north-east wind, which began to blow early in that month. *S. gregaria* was absent from the survey area during the first six months of 1933.

Termites

Ceylon.—The following account of the work carried out on termites by the Division of Plant Pest Control during 1933 is taken from the Report for that year by Mr. F. P. Jepson, Assistant Entomologist and Controller of Plant Pests.

1. *Specimens received for Examination and Report.*—Injury to tea by the termites *Neotermes militaris*, *N. greeni*, *Glyptotermes dilatatus* and *Coptotermes ceylonicus* was reported on several occasions during the year, specimens of each being received. Specimens of tea branches attacked by various scavenging species were also received, one case of interest being the removal of all dead tissue from the main stem of a bush by the rare species *Microcerotermes greeni* which has only been collected on two former occasions. Specimens of *Neotermes greeni* attacking tea were received from Dehiowita for the first time during the year, and new locality records for *Glyptotermes dilatatus* were Kahawatta, Dehiowita and Akuressa and, for *Coptotermes ceylonicus*, Kahawatta, the host plants in each case being tea.

Specimens of *Neotermes greeni* were also received from the Kandy and Kadugannawa Districts, the host being *Grevillea robusta*. This tree is a favoured host of the species, which is widespread in the island.

Coptotermes ceylonicus, which is already a very serious pest of tea and is also known to attack Hevea trees, coconut palms and several green manure and other trees of importance, was found to attack cocoa for the first time during the year. This is one of the most destructive of the Ceylon termites and, in addition to attacking living plants through their root systems from the subterranean nests, is the most destructive of the species which attack building woodwork. The colonies are, evidently, very large and the range of activity wide. The fact that there is no external evidence of the existence of the subterranean nests makes control difficult. Buildings can, with the exercise of due precaution, be protected from the attacks of these insects, but not so living plants, as the existence of the pests is rarely discovered until damage is done and the plants are beyond saving. This species also caused extensive damage to *Grevillea robusta* on a tea estate in the Kelani Valley District.

Cyclotermes redemanni, a common subterranean and mound-building termite, is generally regarded as possessing scavenging habits, usually only dead or diseased plants, or parts of them, being subject to attack by this insect. During the year, however, an instance was observed at Peradeniya which suggested direct injury to *Crotalaria Brownei* plants by this species. The instance can only be regarded as exceptional, as the species is so extremely common that other cases of similar injury are certain to have been observed if the habit was a common one.

The same remarks apply, though not to the same extent, to another subterranean species, *Termes horni*, a large-bodied insect which forms no superstructure. A few instances of damage by this insect to apparently sound and healthy plant tissue have come to notice, although such instances are rare. During the year, somewhat extensive, and apparently direct, injury to Adlay plants (*Coix Lachryma-Jobi*) was reported from Hikkaduwa. The plants were five months old and 50 per cent. of the crop was said to have been destroyed. It is not known, positively, that other factors had not interfered with the proper growth of the plants and that the termite injury was not secondary, but the existence of earlier and occasional records of suspected damage by *T. horni* makes it advisable to regard the species as one which may, under certain circumstances, cause direct injury to apparently healthy plants.

A large number of termite enquiries, accompanied by specimens, received during the year related to injury caused to buildings by these insects, mainly species of the genera *Cryptotermes*, *Planocryptotermes* and *Coptotermes*. These enquiries cover requests for advice on termite-proof construction of dwelling-houses and estate factories, for information as to methods of dealing with buildings which are already infested by these insects, and for information as to whether certain buildings in which cases of illness suggestive of sprue have occurred are attacked by dry-rot or dry-wood termites. Some local interest in the latter subject has been aroused following the publication by the writer of a paper suggesting the possible association between the infestation of bungalow woodwork by the dry-wood termites and the development of certain forms of intestinal illnesses among the occupants of these bungalows. As is well known, dry-wood termites void minute and hard fæcal pellets of very characteristic appearance which are common objects in old buildings, particularly upon the surfaces of articles of furniture upon which they fall from the infested roof-timbers. These fæcal droppings frequently fall into articles of human food, and the possibility of the infection of food by organisms contained in the excrement of these insects appears to be one which is deserving of examination. The intestines of dry-wood termites are known to harbour an extensive Protozoon fauna which has already aroused the interest of several workers, and the fact that they have also been found to abound in bacteria is now engaging the attention of Dr. L. F. Hirst, the Microbiologist to the Colombo Municipality.

Infestation of bungalow woodwork by dry-wood termites was, until recently, believed to be restricted to elevations below 3,500 ft., but cases have been discovered during the year of infestations of estate bungalows at 4,200 ft. in the Talawakelle District and at 4,300 ft. near Badulla and of a building situated at an elevation of 5,700 ft. at Hakgala.

The request to examine the bungalow at Talawakelle arose on account of the two inmates having contracted sprue during their occupancy of this building and the existence of dry-rot was suspected by them. The injury caused to dry timber by species of *Cryptotermes* and *Planocryptotermes* is commonly, but erroneously, termed dry-rot in Ceylon, but the true dry-rot caused by fungi is comparatively rare, while injury due to the agency of the dry-wood termites is extremely common. One instance of the floor joists of a bungalow in the Maskeliya District being extensively infected by a species of true dry-rot fungus was met with during the year. A bungalow in the Madulkelle District, in which many of the past occupants have suffered from intestinal troubles suggestive of sprue, was also found to be severely attacked by dry-wood termites and is now being rebuilt.

Coptotermes ceylonicus, which is a widespread pest of buildings and living plants at low elevations, has been discovered during the year at the exceptionally high altitude of 4,200 ft. in the Talawakelle District. Although, in this case, only recorded as a pest of buildings, the appearance of this destructive tea pest in the centre of an important tea-growing area is disturbing.

The appearance of this same termite on the ceiling boards and wooden trusses of St. Michael's Church, Polwatte, Colombo, caused the Church Committee some concern and assistance was rendered by this Division in attempting to trace the points at which the insects had gained admittance to the building. The building is of cut stone and the insects appeared to be emerging from the masonry walls, in each case, above the supporting interior pillars which were found to be of reinforced concrete, faced with brick. The conclusion arrived at was that the insects had followed the course of the electric light lead casing which was embedded in this brick facing. All casings were, accordingly, exposed for a few inches and will be kept under observation for a renewal of activity, which has, in the meantime, ceased.

Very extensive injury was caused to an estate factory near Wattegama by *Coptotermes ceylonicus.* The insects had obtained access to the wall at many points and had completely destroyed the upper floors of the building. The problem of dealing with extensive infestations of this nature in old buildings, especially when the insects possess uninterrupted access to the walls from the soil at many points, is difficult to solve. Unless the continued entry of the insects to the building can be prevented all timber replacements are attacked within a short time, and, in many cases, the most economical course is to rebuild. The very extensive injury caused to Ceylon buildings by termites could be prevented if reasonable care were taken during construction by installing termite-proof barriers between the foundation and upper walls.

A species of *Eutermes* caused extensive damage to a bungalow at Madulkelle during the year. This type of termite injury is uncommon in Ceylon although a few similar cases have been seen.

2. *Bionomics.*—This branch of the termite investigation has again been continued by Mr. P. D. Pinto. Reference was made in the report for last year to the development of rudimentary wing pads on the part of the most advanced members of two colonies of *Neotermes militaris* raised from eggs laid by winged adults. These two colonies are still flourishing and additional members have developed wing pads during the past year. The individuals which were reported to have reached this stage a year ago have now developed wing pads which are about half their ultimate size. These colonies are now seven years old and it is hoped that the final winged state will be reached within the course of the next year.

In the report for last year, mention was made of the development of a colony of *Glyptotermes dilatatus* raised from a pair of neoteinic (apterous) adults. This colony is now nearly six years old and is in a thriving condition. As has already been mentioned, winged forms have been produced from eggs laid by wingless forms in a period of four and a half years, and during the period covered by the present report further winged adults have been produced. A small swarm of these issued from the nest towards the close of the year. The community now consists of both winged and wingless reproductive forms, soldiers, nymphs and larvæ.

Five colonies of a species of *Planocryptotermes* are now five and a half years old. One of these, raised originally from eggs laid by a winged pair, gave rise to winged adults in June last, the complete life-cycle from the date of oviposition to the appearance of the winged forms having occupied a period of four years, ten months and three weeks. A second colony, also raised from eggs produced by a winged pair over five years ago, contains nymphs with small wing pads.

Two other colonies of the same species, developed from eggs laid by neoteinic pairs, now possess nymphs with long and short wing pads, respectively. The fact that, on a previous occasion, winged adults were developed from eggs laid by a neoteinic pair in a period of two years and seven months indicates that the life-cycle period is a very variable one.

Three colonies of a species of *Cryptotermes* are four and a half years old. In one of these the nymphs now possess long wing pads and the final development to the winged reproductive state should take place within a few more months.

One colony of a species of *Cryptotermes* is of special interest, being the result of mating a male winged adult with a female neoteinic adult. Some of the nymphs in this colony have now developed long wing pads while many are in the earlier stage with small pads. It has already been demonstrated at Peradeniya that winged adults can be raised from eggs laid by neoteinic pairs, but a similar result, following the union of a wingless female with a winged male, was not anticipated. The development of the most advanced nymphs of this colony to the winged state should take place in the near future.

3. *Tests of Building Materials.*—Increasing interest has been shown during the year in the selection of termite-proof materials for incorporation in local buildings. Many ceiling and insulating fabrics are widely advertised as possessing termite-proof qualities, these claims having been based upon tests conducted in other countries. In certain instances these claims of manufacturers of so-called "termite-proof" materials cannot be supported under Ceylon conditions. Two insulating and ceiling materials, of British manufacture, have been received for test from several different sources, including the Public Works Department and local architects. The materials are

advertised as being proof against termite attack, but repeated tests conducted by this Division have shown that they are readily attacked by *Hypotermes obscuriceps*, a common subterranean species of termite which frequently invades Ceylon houses, and also by dry-wood termites of the genus *Cryptotermes*. Further samples, treated by a new process, have now been submitted and are still under test, both materials showing slight injury by *H. obscuriceps*.

Another compressed-fibre material, stamped as " termite-proof " on every sheet, was readily attacked by the above species within a few days of the commencement of the test.

Three samples of canvas, claimed to be termite-proof by the manufacturers, were destroyed by *H. obscuriceps* within a few days.

The tests with the Burmese timber, *Hopea odorata*, commonly called " Thingan," which were referred to in the report for last year, have been discontinued. The samples resisted attack by *Cyclotermes redemanni* for a period of twenty-six months, although remaining in an active nest of this species during this time. Previous tests against *Hypotermes obscuriceps* and *Termes horni*, both troublesome termites in local buildings, also indicated the resistant properties of this timber, which is extensively used in Burma on this account. Attempts to induce a species of *Cryptotermes*, one of the dry-wood inhabiting termites, to feed on this timber have also failed, the insects dying within a few days.

Of two pieces of timber treated with a rubber distillate wood-preservative, submitted for test by the Rubber Research Scheme of Ceylon, one was completely destroyed in five months by *Cyclotermes redemanni*. The second sample has not been damaged and is still under test.

4. *Control.*—Unfortunately the Paris Green treatment of *Neotermes militaris* has ceased, temporarily, on certain tea estates owing to the present need for reducing costs to a minimum. However, many estates are still continuing the treatment with satisfactory results. Recent figures obtained from one estate, which has continued the treatment without interruption since 1926, indicate that the cost works out at approximately Re. 1.10 per acre over the portion of the estate which is infested, an average of forty-five bushes per acre requiring treatment. The number of treated bushes on which these recent figures are based is 8,000. An intensive campaign has recently been commenced on another estate in the same district where the attack is probably far more severe. The fact that the Albizzias, which are interplanted with the tea on this

estate, are also very severely attacked constitutes a problem in itself which is unlikely to be satisfactorily solved until these trees are entirely removed from the areas concerned. The advisability of avoiding the establishment of green manure trees of a woody habit of growth in fields affected by *Calotermes* has been stressed on more than one occasion. In the district in which the estates referred to above are situated even dadap and *Crotalaria* are attacked by *Neotermes militaris.*

This pest is so widespread, and so firmly established in the Dimbula and Maskeliya Districts, that superintendents of affected estates should concentrate upon its control in order to preserve the unattacked portions of their estates from infestation. In many cases this can be accomplished without difficulty, but if the pest is allowed to increase, unchecked, the problem of dealing with the situation in the future will prove both difficult and costly.

Estates which have adopted the Paris Green treatment against *Glyptotermes dilatatus* have reported satisfactory results. This termite, as a pest of tea, does not, however, lend itself to control by Paris Green injection as readily as does *Neotermes militaris*, as a single bush may harbour several distinct and unconnected colonies in the different branches. A single injection can only, therefore, be expected to destroy the individuals contained in the particular colony which has been penetrated by the injection apparatus, and where there is reason to suspect that a bush contains more than one attacked branch the treatment of all such branches is advisable, but under no circumstances should branches be injected unless they are positively known to contain galleries of the insect.

The problem of *Coptotermes* control has not yet been investigated. As species of the genus invade their host plants through the roots from nests which may be situated far distant, and as there is no external indication of the situation of the central nests, the problem of dealing with this group of termites is certain to present many difficulties.

The petrol treatment of the central nests of mound-building termites has continued to prove entirely satisfactory. The method can be calculated to secure a 100 per cent. mortality of the treated colonies and the cost is not excessive. Further, petrol can be obtained throughout the island. Over one thousand mounds have been successfully treated in the Royal Botanic Gardens, Peradeniya, and a large number also in the Botanic Gardens, Heneratgoda, and Experiment Stations at Godakawela and Embilipitiya. Nests in the laboratory compounds at Peradeniya are treated as they make their presence known.

INSECTICIDES

Derris

Ceylon.—According to the report of Mr. W. C. Lester-Smith on the School Farm and Experiment Station, Peradeniya, for the year 1933, the growth of *Derris malaccensis* and *D. elliptica* under old rubber has been most unsatisfactory. Derris, therefore, is not likely to prove a practical proposition in old rubber, though it might prove a suitable catch crop in young rubber clearings. The difference in the growth of both species under old rubber, and out in the open as a pure crop in plots A4, B4 and 20C, is more marked than ever. Under the old rubber the Derris has made practically no growth during the past year or more. There is little to choose between the growth of either species under the old rubber, but, if anything, *D. malaccensis* shows a greater tendency to survive. In the open the above-ground growth has been quite good, *D. malaccensis* having made better growth on the whole. The harvesting of roots of both species is being carried out after growth periods of approximately 16, 20, 24 and 28 months. The weights of roots and, if necessary, tops, are being taken and the roots sun-dried and samples submitted to the Agricultural Chemist for analysis. Records are available at present only of the first harvesting of *Derris malaccensis* after 16 months' growth. The total number of plants harvested was 237; the wet weight of the roots was 16·5 lb. (the weight of tops was 251 lb.) which gave 6·25 lb. of dry roots six weeks after harvesting. The roots were allowed to dry out at room temperature in the Store, the weather being too wet to sun-dry them. They were graded into three sizes:

(*a*) with diameters of about $\frac{1}{4}$ in.
(*b*) with diameters of about $\frac{1}{8}$ in.
(*c*) with diameters of about $\frac{1}{16}$ in. and less,

all of which would come under the arbitrary term of "fine roots" in the classification adopted in Malaya. The analyses of these roots, figures supplied by the Agricultural Chemist, were as follows:

Size.	Total weight of dry roots harvested (approx.).	Moisture	Ether extract.	Ether extract on moisture free basis
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*
(*a*) $\frac{1}{4}$ inch .	60	10·30	19·65	21·92
(*b*) $\frac{1}{8}$ inch .	27	10·75	18·05	20·23
(*c*) $\frac{1}{16}$ inch .	13	10·73	13·30	14·88
	Average .	10·69	17·00	19·01

Pyrethrum

Ceylon.—Dr. J. C. Haigh, Economic Botanist, in his report for 1933, states that as a result of a report upon the successful application of an extract of pyrethrum as a mosquiticide, a small quantity of seed of *Chrysanthemum cinerariæfolium* was obtained for trial. At Peradeniya germination was poor, and the seedlings were weakly, so that only very few have survived, but at Bandarawela a number of vigorous seedlings were raised and developed into sturdy plants. They commenced to flower a year after sowing, but received a set-back from the heavy rains of the North-east monsoon. It is possible that the conditions of the dry zone will be most suitable for successful cultivation of this plant, and arrangements are being made to supply plants to the Experiment Stations at Anuradhapura, Maho and Bata-ata.

CEREALS

Rice

Ceylon.—Dr. J. C. Haigh, in his report on the work of the Division of Economic Botany for 1933, refers to a series of experiments on paddy cultivation which is being conducted in collaboration with the Agricultural Chemist. The general plan of the series is to carry out trials of agricultural practices, such as manuring and transplanting, and at the same time to analyse chemically the crop and the soil at frequent intervals, so as to discover the reaction of plant and soil to treatment and explain the reasons for the results obtained. The first experiment of the series was described in Dr. Haigh's last report (see this BULLETIN, 1933, **31**, 243), and has been published in detail in the *Tropical Agriculturist* (Vol. LXXXI, No. 1, July 1933). The second experiment was started during Maha 1932–33 and consisted of six treatments (transplanting, broadcasting, and thinning and broadcasting, with and without manure in each case), in randomised blocks, replicated five times. The manure was ammonium phosphate applied at the rate of three-quarters of a hundredweight per acre. The experiment was continued during Yala 1933, for the observation of residual effect, but the plots were completely destroyed in the May flood. The full results will be published in the *Tropical Agriculturist*, but the following summary, taken from Dr. A. W. R. Joachim's report on the work of the Chemical Division for 1933, may be quoted.

The results, so far as they go, clearly demonstrate the superiority of transplanting alone over broadcasting and broadcasting and thinning, even when accompanied by manuring. The effect of manures, irrespective of the system of cultivation, is definitely significant. Maturity appears to be hastened by manuring in the case of the broadcasted crops.

The chemical data confirm what has previously been found in regard to transplanted paddy. At flowering the transplanted crop absorbs only about 50 per cent. of its nitrogen and phosphoric acid at harvesting and about 90 and 83 per cent. respectively of its potash and lime. The broadcasted and thinned plots, on the other hand, absorb at flowering about 65 and 70 per cent. respectively of the nitrogen and phosphoric acid at harvest. Even higher rates of absorption have been found in the case of the solely broadcasted plots. The potash and lime absorption figures are also higher with the broadcasted crops at this stage of their growth. The data, therefore, indicate that while the transplanted crop continues to absorb nitrogen and phosphoric acid steadily till a little before harvesting, the unmanured broadcasted crops cease to function in this respect a short time after flowering. Manuring, on the other hand, appears to enable the plant to lengthen its fertiliser absorption period and consequently to produce higher yields. The effect of transplanting appears to be similar in that the crop is able to make better use of the fertilising constituents in the soil, through their absorption over a greater period of its growth. The composition of the crop at harvest from differently treated plots does not show any appreciable variation. At harvesting the amounts of fertilising constituents removed in the crop are shown in the table below.

	Nitrogen Lb per acre	Phosphoric acid Lb per acre	Potash Lb per acre	Lime. Lb per acre.
Transplanted :				
Manured . . .	29·0	14·9	30·8	12·1
Unmanured . .	23·6	10·6	31·5	10·8
Mean . . .	26·3	12·7	31·1	11·5
Broadcasted and thinned :				
Manured . . .	22·1	12·2	28·7	12·3
Unmanured . .	21·8	8·9	35·7	14·4
Mean . . .	21·9	10·5	32·2	12·3
Broadcasted :				
Manured . . .	21·2	9·4	25·0	10·3
Unmanured . .	17·3	7·2	24·7	9·3
Mean . . .	19·2	8·3	24·8	9·8

This table will be seen to bear out some of the observations made in regard to the effectiveness of the planting systems and of manuring in relation to fertiliser intake and crop yield. The amounts of fertilising constituents removed by the transplanted crop are noted to be much the same as those found in the previous investigation.

The soil data indicate that the fertiliser increases appreciably the reserve of available ammonia in the soil and that this increase is generally maintained during the whole of the crop growth. There does not appear to be any proportionality between decrease in available soil ammonia and nitrogen intake by the crop.

The third series of these investigations, embracing both field and laboratory work, was started in the *Maha* season. Two schemes of experiments were devised. The first was designed to determine the best time of application of manures and whether three small doses of manure applied at different times of the plant's growth were preferable to two larger doses (one before transplanting and one before flowering), or to a single dose applied before transplanting. Two grades of ammonium phosphate were used for comparison. The object of the second investigation was to ascertain which was the most efficacious type of phosphatic fertiliser for paddy—ammonium phosphate, superphosphate, bone meal or mineral phosphate—the quantity of nitrogen, which was supplied in the form of sulphate of ammonia where necessary, being kept constant.

PULSES

Green Gram

Nigeria.—The Botanical Section, Department of Agriculture (Northern Provinces), reports that green gram (*Phaseolus Mungo*), introduced from Nyasaland in 1930, has practically passed out of their hands into trials on a field scale and even in some cases to the native farmer. The seed is now appreciated as making palatable food for man, and the plant generally is a useful fodder which can be interplanted in cereals.

FRUITS

General

Ceylon.—The following account of work carried out on fruit and fruit products by the Chemical Division, Department of Agriculture, is taken from Dr. A. W. R. Joachim's report for the year 1933.

Canning and Bottling.—Towards the middle of the year a small hand canning and bottling outfit for food preservation under home conditions was received and a series of preliminary trials on the canning and bottling of mangoes, pineapples, papaws, tree tomatoes, guavas and jak begun. The effect of the following factors on flavour and keeping quality were investigated : degree of maturity and condition of fruit, preliminary treatment of fruit, syrup concentration, time and temperature of sterilisation, technique of filling, exhausting and processing. Owing to limitations of time only one variety of mango—the local Jaffna—obtained from one source was experimented with.

Samples of the canned mangoes were tasted by a number of people and reported on favourably. Tentatively, it may be stated that so far as this variety of mango goes, the sterilisation period for canning small and large tins need not be longer than 20 and 25 minutes respectively. Syrup concentrations of 25 to 35 per cent. appear to be the most suitable. The correct degree of maturity and firmness of fruit is, however, essential for success. Pineapples have also given successful results. Tree tomatoes give a very attractive bottled product and should prove popular abroad. Papaws appear to require syrup concentrations of from 30 to 50 per cent. For bottling generally a sterilisation temperature of 180° F. has been found very suitable, a period of retention at this temperature of from 20 to 30 minutes being required if heating has been done from the cold. Preliminary trials have also been made with the bottling of the water and kernel of the young coconut, and the results so far obtained appear to be promising. Some of the samples are now over eight weeks old, and appear to have kept well. A few samples of canned fruit are being sent to England to be examined at institutions specialising in this line of work. It is proposed this year to send a small commercial consignment of local canned fruit to test the possibilities on the English market.

Fruit Drying.—Samples of " banana figs " were prepared from *embul hondarawala* and *suwandel* plantains. The former were not found suitable for stewing, owing to the astringency produced by the tannin contained in the numerous seeds present in this variety. They were, however, very palatable eaten as dried fruit or preserved in soft sugar. If a suitable variety of sour plantain with but few seeds could be obtained, there should be a possibility of a small village industry in this line. The *suwandels* gave a dried product which stewed well. The conditions for the preparation of a crisp biscuit of dried breadfruit were determined at the request of an enquirer ; an attractive product can be obtained both by sun-drying and oven-drying. Preliminary trials with the preparation of slabs of wood-apple pulp were fairly promising.

Fruit Juices, Cordials, Essences and other Products.—In the early part of the year attention was devoted to the preparation of oil from the rind of limes (*see* p. 298). The juice from the fruit was used for the preparation of bottles of sterilised lime juice and lime-juice cordial, after a satisfactory technique for small-scale work had been developed. The samples of the cordial were reported to compare favourably with the imported article. From the lime juice was also prepared a large sample of citrate of lime. In view, however, of the artificial synthesis of citric acid from sugar by-products, the manufacture of this product locally, on a commercial scale, is not to be recommended. Trials were also made with very fair success with the preparation of essences of lemon, pineapple and vanilla. The trials with mangoes were not so successful.

The Artificial Ripening and Coloration of Fruit.—In continuation of work on this subject referred to in the report for 1932, carefully carried out quantitative experiments were undertaken to determine whether ethylene gas had any effect on the ripening of oranges. These indicated that no appreciable changes in the composition of the fruit were brought about by the gas treatment. There was, however, a distinct fall in the total sugar content of treated fruit as a result of increased respiration. The gas was found to have no effect on the colour of the local Jaffna mango, but its ripening was markedly hastened. A paper on the work done on this subject was published in *The Tropical Agriculturist* of August 1933.

Bananas

Ceylon.—According to the report of Mr. Malcolm Park, Mycologist to the Department of Agriculture, for 1933, bunchy top disease of plantains has not been recorded from Tissa area of the Magam Pattu in the Southern Province. Plantains are grown extensively in this area, and a detailed inspection of the plantains was undertaken in February–March. No sign of the disease was seen or reported and, in consequence, legislative steps have been taken to prevent the introduction of the disease into this district, which has now been declared a free area. This progressive step is important, since it will be possible for growers in the future to obtain planting material free from bunchy top disease when it is required.

Further investigation has confirmed the observation made previously that both bunchy top and Panama or wilt disease are most commonly spread in Ceylon by means of infected suckers used as planting material. This stresses the importance of the complete eradication of the whole of every clump or stool in which one or other of these diseases occurs. The eradication of plants by digging up and burning is not easy of proper execution, and experiments have been completed during the year testing the value of toxic oils as agents for the destruction of diseased plantain clumps, as has been done in the West Indies. Complete success was obtained using a heavy fuel oil and the results of the experiments were discussed fully in the *Tropical Agriculturist* for August 1933. It is to be hoped that this cheap, simple and effective method of treatment will be generally adopted.

Cashew Nuts

Ceylon.—Dr. A. W. R. Joachim, in his report on the work of the Chemical Division for 1933, states that in view of enquiries made by the Registrar-General about the "vitapack" process for preserving cashew nuts, a series of trials was started to determine the keeping quality of these nuts in tins and in bottles under varying conditions—in unsealed and sealed receptacles in the presence of air alone, carbon dioxide alone and carbon dioxide air mixtures. The experiments have indicated that the packing of well-dried cashew nuts in well-sealed receptacles containing dry carbon dioxide gas is a very effective means of preserving them for no less than eight months (the duration of the experiment). The trials also appear to indicate that, provided the nuts are thoroughly well dried, they can be preserved for this period of time in well-filled and well-sealed containers without carbon dioxide. This observation can perhaps be explained by the fact that cashew nuts assimilate oxygen from the air in the container and respire carbon dioxide.

Citrus

Ceylon.—Mr. W. C. Lester-Smith, in his report on the work of the School Farm and Experiment Station, Peradeniya, for 1933, includes the following statement regarding experiments with citrus trees.

The quality of the fruit obtained from the South African 1928 planted grapefruit has improved slightly, but the yields are distinctly poor compared with last year when the weather was definitely more suitable. The fruiting records of the eleven trees which commenced bearing last year and of four additional trees which came into bearing for the first time this year are as follows :

Tree No.	Variety	No of Fruits.	
		1932	1933.
F 14/10	Cecily Seedless	7	2
F 14/7	„ „	30	2
F 14/14	„ „	—	3
F 14/1	Ellen	18	6
F 14/2	„	75	7
F 14/3	Foster	22	10
F 15/17	Marsh's Seedless	1	5
F 15/18	„ „	27	4
F 15/16	„ „	—	29
F 14/6	McCarty	1	1
F 14/11	„	76	38
F 14/8	Triumph	26	51
F 14/9	„	—	12
F 14/5	Walters	127	11
F 14/18	„	—	13
	Total	410	137*
	Average per tree	37	12*

The collection of individual yield records from the five mature seedling grapefruit trees planted in 1920 was continued. The records of these trees are as follows:

Tree No	No of Fruits	
	Average 1930-32	1933
F 5/2	31	16
F 5/3	105	128
F 5/5	8	5
F 5/11	33	53
F 5/13	45	14
Total	222	210
Average	44	43

Three varieties of sweet orange, received from the Director of Agriculture, Trinidad, and planted in 1927, fruited for the first or second time this year and the individual yield records of these plants for the last two years is as follows:

Tree No.	Variety	No of Fruits	
		1932	1933
F 15/1	Navel Orange	4	32
F 15/2	Jaffa Orange	19	79
F 15/4	Lue Gim Gong Orange	—	8

* For the same 11 trees as in 1932.

Yield records are being continued and those of the Jaffa orange, which has produced quite good-quality fruit this year, may be of interest later as this tree shows some indication of being a heavy yielder.

There has been considerably less infection from citrus canker since the commencement of the regular hand picking and burning of all infected leaves and fruit, which has been continued throughout the year. A rigorous pruning-off of all cases of branch canker was carried out during the year, and now that the old trees which were a continual source of infection have been dealt with it is hoped that it may be possible to prevent further trouble from citrus canker. Plants of two sweet orange varieties, (F 15/1) Navel Orange and (F 15/2) Jaffa Orange, the yield records of which are quoted above, were attacked by mildew (*Oidium tingitaninum*) both this year and last, being affected more readily and to a greater extent than any other sweet orange or grapefruit plant. This trouble has been satisfactorily controlled by a proprietary colloidal lime-sulphur solution which leaves no visible deposit and has been substituted for the lime-sulphur mixture previously used. It is of interest to record that blemishes on the mature fruit of these trees, which have been seen previously in other parts of the Island on sweet orange and other types of citrus fruits and were believed to be caused by wind injury, are regarded now, almost with certainty, as being caused by mildew (*Oidium tingitaninum*) attack on the young fruits when a quarter developed or less (from one to one and a half inches in diameter), and when the rind tissues are susceptible to infection. The identity in the shape of the mildew-affected patches on the young fruits and the shape of the blemishes on the mature fruits has led to this conclusion.

A case of fruit-fly attack on grapefruit was recorded in April and immediate precautions were taken to prevent the further spread of this pest by stripping the trees of all fruit three-quarters ripe and over, and destroying these fruits by fire. This necessitated the destruction of a considerable number of fruits which were approaching maturity, but the danger involved appeared to warrant such drastic measures being taken. Only two further cases of attack have been recorded and it is believed that the outbreak was effectively controlled. Baiting was also attempted subsequent to the removal of fruits, but no fruit flies were trapped. Some cases of attack by the black citrus aphis occurred and were eventually controlled by spraying weekly for about two months with a nicotine sulphate and soap solution.

Mr. Malcolm Park, Mycologist to the Department of Agriculture, in his report for 1933, states that there was a marked increase in the number of specimens of diseases of citrus received by his Division for examination and report during the year. This is an indication of the increasing interest taken in the cultivation of citrus in Ceylon rather than of the increased incidence of fungus diseases. Citrus mildew (*Oidium tingitaninum*) was found attacking lime leaves on one occasion, which is noteworthy since this plant is normally resistant to the disease. Mildew was also found on orange plants at an elevation of 6,000 ft., at which elevation the disease rarely occurs. At medium elevations mildew is extremely common on orange, especially in the wetter zones of the island, and the repeated defoliation caused by the disease is one of the chief causes of the unthrifty appearance of so many of the orange trees in Ceylon and is often the precursor of die-back. It has been demonstrated conclusively that two or three weekly sprayings with a standard sulphur spray (e.g. lime-sulphur or colloidal sulphur) each time a new flush of growth occurs provide adequate control of the disease. This and other diseases of the foliage and branches of citrus are more common than they need be and their severity is increased by the lack of intelligent pruning. Smallholders and village cultivators rarely prune their citrus trees and education in this direction is desirable.

Citrus canker (*Pseudomonas citri*) is very common at elevations up to 3,000 ft. and its occurrence may well prove to be a limiting factor in the cultivation of citrus in certain areas. The control of this disease provides a problem which is receiving attention. Spraying alone, although it reduces considerably the incidence of the disease, has been shown not to provide control sufficiently exact to prevent considerable damage. The Officer-in-charge, Experiment Station, Peradeniya, has carried out an interesting experiment in which every leaf, twig and fruit showing infection has been regularly removed from citrus trees. The labour involved has been considerable but the trees are now free from the disease and reinfection is becoming progressively less common. It is hoped that by this treatment, combined with regular spraying, it will be possible to check the disease and to keep it in control indefinitely. One of the main difficulties experienced in the wet seasons, when diseases are especially active, is that it is so often impracticable to spray as the trees are too wet.

Inoculation experiments have been carried out with pure cultures of *Corticium salmonicolor*, the fungus causing pink disease. The fungus, when isolated from a diseased apple branch, was shown to be as actively parasitic on citrus as an isolation from citrus, indicating the absence of differentiation into biological strains. Positive infection was readily obtained without wounding. The application of a 50 per cent. aqueous solution of a standard tar-acid disinfectant, such as Brunolinum Plantarium, has been shown to prevent the spread of the disease and adequately to protect healthy branches.

Nigeria.—The report of the Botanical Section, Department of Agriculture (Northern Provinces), for the half-year, July 1 to December 31, 1933, states that trials with the following stocks, with grapefruit as scion, were started in 1932 : Grapefruit, Sweet Orange, Sour Orange, Acid Lime, Rough Lemon, Shaddock, Mandarin and Tangerine. It is already clear that Acid Lime and Rough Lemon produce the greatest vegetative growth and are the most drought-resistant.

Pineapples

Nigeria.—Mr. F. D. Golding, Senior Entomologist, Department of Agriculture, in his report for the half-year, July 1 to December 31, 1933, states that a study has been made of the scale insect, *Pseudococcus brevipes* Ckll., which is known to cause wilting of pineapples in Hawaii. Two species of ants were found to be associated with the scale insects in Nigeria. *P. brevipes* usually occurs in the axils of the lower leaves, but was also present on the roots of some plants - a fact which makes control by chemical methods difficult. Although wilt is present on the Government Farm at Agege it appears to be completely absent from native farms in that neighbourhood. *P. brevipes* was abundant on pineapples on the native farms, and it is doubtful if the wilt disease in Nigeria is identical with Hawaian wilt.

SPICES

Ginger

Ceylon.—Dr. A. W. R. Joachim, Agricultural Chemist to the Department of Agriculture, in his report for the year 1933, states that the ginger manurial trials which were being carried out at Siyambalagoda were completed in January and the results examined statistically. Sulphate of potash and the mixed manure gave significantly higher yields than the control and the superphosphate and nitrate of soda treatments. The two latter did not give significantly higher yields than the control. A full report of the trials was published in the May 1933 issue of *The Tropical Agriculturist.*

A comprehensive series of manurial trials to compare the effects of a complete fertiliser and cattle manure, with and without lime, and with and without a mulch of straw on each of two varieties of ginger—the Nugegoda and the local variety—has been started at the ginger trial ground at Giragama. In co-operation with the Divisional Agricultural Officer, central trials were also begun to determine (1) the optimum seed rate for ginger, (2) the best method of planting seed ginger.

A great deal of attention was devoted to ginger curing during the first quarter of the year. The curing was carried out at Ranawana, just over two miles from Peradeniya. Nineteen cwts. of raw ginger were cured by different modifications of the lime-sulphur process and a great deal of useful information was secured thereby. A study was also made of ginger curing by the Jamaican process with very encouraging results. A full report of the results of the investigation was published in *The Tropical Agriculturist* of May 1933. The second-grade dry material was ground at a mill at Matale and milling data obtained. Sample packages of the ginger were sent to the Imperial Institute and to local firms and retail traders for valuation and report. The samples were very well reported on locally, but there appears to be but little demand for a high-quality product. The report from the Imperial Institute was to the effect that though the samples were very favourable so far as appearance, fracture and aroma went, there was no market for sulphur-cured or for ground ginger in Great Britain.

According to the report of Mr. Malcolm Park, Mycologist to the Department of Agriculture, for 1933, some attention was given to the diseases of ginger during the year. The occurrence of a disease which is apparently soft rot, caused by *Pythium Butleri,* is noteworthy. The disease occurred on ginger newly imported from India where the disease is reported to cause very severe losses. Every effort has been made to ensure that ginger affected by this disease is not distributed for seed purposes. The question of the control of ginger diseases has been considered. Soaking of ginger rhizomes in a 0·1 per cent. aqueous solution of corrosive sublimate for two hours has been found not to affect germination adversely. A field experiment has therefore been planned to determine if this treatment of " seed " ginger will lessen the incidence of the disease caused by *Rhizoctonia solani* and *Sclerotium Rolfsii.*

OIL SEEDS

Coconuts

Ceylon.—The report of Mr. Malcolm Park, Mycologist to the Department of Agriculture, for 1933, contains the following account of work done on diseases of coconuts during the year.

A further year's record has been obtained of the yield of the group of palms affected by root disease, referred to in previous reports. The yields of certain palms continue to show a steady diminution, but in others there has been an improvement and the total yield of the group of palms is greater than that of last year.

Figures have been obtained of the yields of six estates in the Puttalam district. These estates suffered from unusually severe drought in 1931. The effects of the drought were discussed in the *Tropical Agriculturist,* Vol. LXVIII, 1932, p. 11. Subsequent to the drought the yields of the estates dropped rapidly. The lowest yield, which was approximately one-third of the average yield for the last seven years, was obtained thirteen months after the conclusion of the drought. The yields have subsequently improved. The data are not yet complete and it is proposed to discuss them more fully when the yield records for another six months have been obtained. It would appear that severe drought affects adversely all stages of fruit and flowers, even those in the earliest stages of development.

An outbreak of Leaf Bitten or Scorch disease of coconut palms, caused by *Ceratostomella* (*Thielaviopsis*) *paradoxa,* which occurred in the Matale district was investigated. This was the first occasion on which the disease had been recorded in Ceylon. The disease affects the young folded leaves which constitute the cabbage, about half-way between the base and top. The infection, which is at first localised, penetrates and kills the midrib and leaflets of the folded leaves at this point and the upper parts of the leaves consequently die. The trees may recover and the leaves when unfolded have a bitten or charred appearance. Frequently a secondary rot of the cabbage sets in with the result that the bud is destroyed, and this stage of the disease may be consequently confused with bud-rot. Diseased tissues are attractive to red weevil (*Rhynchophorus ferrugineus*) and the disease is often followed by red weevil attack.

Inoculations with pure cultures of the fungus have shown that it is the cause of the disease although positive results have only been obtained through wounds. *Ceratostomella* (*Thielaviopsis*) *paradoxa* has now been shown to be the cause of stem-bleeding disease, leaf-break disease and leaf-bitten or scorch disease of coconuts.

The treatment recommended is the excision of the diseased cabbage tissue and the application to the cut surface of a mixture of one part salt, one part powdered lime and one part powdered copper sulphate. Complete recovery after treatment has been reported. The disease is favoured by wet weather and by damp, overcrowded conditions.

Ground-nuts

Nigeria.—The report of the Botanical Section, Department of Agriculture (Northern Provinces) for the half-year, July 1 to December 31, 1933, contains the following account of experiments with ground-nuts conducted at the different Agricultural Stations.

1. *At Zaria.*- The selected strain of erect ground-nuts, C.C., which had yielded on an average 24 per cent. higher than the Standard erect type in three years of trial, was tested again in 1933 with the following result :

Average yield of 12 plots of Standard = 575 lb nuts per acre
Average difference of 11 plots of C C = 4·5 ± 24·9 lb nuts per acre

The difference is insignificant and the result disappointing. The vegetative growth was greater than Standard as in previous years, a good point where ground-nut tops are valued highly as fodder.

Strain C.C. was distributed to several out-stations for trial in 1933. The Zaria standard was, in most cases, sent as well because local erect types were not available. At Kano, Gusau and Sokoto there were definite yield trials with the following results.

Kano

S C versus C C

Average yield 17 plots S C . .	1,329 lb kernels per acre
Average difference 16 plots C C .	— 88 ± 46 lb kernels per acre
	Odds 43 : 1

Strain S.C. is a selected spreading strain derived from the local type at Kano.

Sokoto

		"Odds" in difference being significant.
Average yield of 9 plots of local spreading type	353 lb per acre	—
Average difference of 4 plots Strain C C	+ 181 ± 28·0	∞ : 1
Average difference of 4 plots Zaria standard	+ 145 ± 28·0	—

Gusau

Average yield of 9 plots of Zaria standard	266 lb. per acre
Average difference of 8 plots Strain C.C.	+ 27·5 ± 33·4

The yield was depressed at Gusau by rosette disease.

At Kafin Soli and Daure (100 and 170 miles north of Zaria, respectively) the yields from single plots of about 1 acre were as follows :

Kafin Soli

In two adjacent plots of 1½ acres :	
Local spreading type	1,062 lb. nuts per acre
Strain C.C.	1,160 " "
In another two adjacent plots of 1 acre :	
Zaria standard	1,070 lb nuts per acre
Strain C.C.	1,094 " "

Daure

Strain C.C.	1,519 lb. nuts per acre
Local variety	750 " "

The plots at Daure were on different parts of the farm.

2. *At Kano.*—There were two yield trials, a large one to test the old Strain S.E. against two more recent ones and Standard, and a small one to test still newer strains. The results were as follows :

Large-scale Trial : Lay-out—6 Randomised Blocks

	Yield of kernels per acre. lb.	Yield as per cent of standard.
S C.	1,327	107
C.N.	1,211	97·5
K.J.	1,212	97·5
Standard	1,243	100
Standard Error	25	2

S.C. was significantly better than Standard.

Small-scale Trial : Lay-out—Latin Square

Strain.	Yield of kernels per acre. lb.	Yield as percentage of Standard.	Threshing percentage.
1	930	109·5	72·5
2	856	101	67·2
3	935	111·5	72·2
4	811	95·5	75·0
5	1,061	125·0	72·8
6	833	98·5	64·2
7	819	97·0	68·2
Kano standard	847	100	75·4
C.C.	999	118	76·6

The results of the small-scale trial showed that Strain 5 is significantly better than 2, 4, 6, 7 and Standard, and that C.C. is significantly better than 4, 6, 7 and Standard. It is noteworthy that 5, 7 and C.C. were imported from Zaria. All except C.C. were spreading types. Spacing was 3 ft. × 1 ft.

Tung Oil

Ceylon.—Mr. W. C. Lester-Smith, in his report on the work of the School Farm and Experiment Station, Peradeniya, for 1933, states that the total number of plants of *Aleurites montana* now growing in the Terraced Valley is 141. The growth of all the plants has been poor on the whole, but it is noticeable that the plants which have made the best growth are those situated where they are not exposed to much wind and where the drainage is good. The vacancies which had to be filled where plants had died were nearly all on terraces where standing water was present after heavy rain. The soil of much of this area is probably too heavy for *Aleurites montana* to make good growth. A few plants flowered during the year but none have set any fruit, and all the flowers examined were staminate. Arrangements have been made to manure all the plants early next year. The one thirteen-year-old bearing tree near the Store was root-pruned early in the year before it commenced flowering, preparatory to moving it to a better site later on. It flowered and fruited fairly well and the harvesting of fruits commenced at the end of August and finished on January 3, 1934. The total number of ripe fruits collected was 364 compared with 265 in 1932 and 262 in 1931. The harvesting of these was distributed during the fruiting months as follows:

1933	August . .	2
	September . .	15
	October .	212
	November	42
	December	87
1934	January .	6

The total weight of green fruit as harvested was 30 lb. 12 oz. (an average of 1·35 oz. per fruit) which when well dried weighed 12 lb. 15 oz., and from which were obtained 1,043 good clean seeds weighing 5 lb. 9 oz., an average of 176 seeds per lb., compared with an average of 158 last year.

ESSENTIAL OILS

Ceylon.—The following account of experiments carried out with various essential oils is taken from Dr. A. W. R. Joachim's report on the work of the Chemical Division, Department of Agriculture, for the year 1933.

1. *Geranium Oil.*—The distillation of the essential oil of scented geranium (*Pelargonium graveolens*) from plants grown at Hakgala was continued at different times during the year when material was available. The yield of oil from flowering shoots was found to be slightly lower than

that from material which had not flowered, on the average 0·12 per cent. of oil being obtained from the former as against 0·14 per cent. from the latter. A second sample of mixed material distilled in November gave a yield of only 0·1 per cent. The time of cutting may perhaps have some effect on yield of oil. About 17 cwts. of leaf material were distilled altogether. Two samples of oil from flowering and non-flowering material respectively were sent to the Imperial Institute for valuation and report, and two other samples have just been dispatched. The report on the first set of samples was distinctly favourable, one firm of distillers reporting as follows: "We find the odour of both samples very good. If bulk deliveries could be maintained we think the oil should find a ready market in this country. We value the oils from Ceylon at about 17*s.* to 18*s.* per lb., the price of Bourbon geranium oil to-day being about 20*s.* per lb." A perfumery expert who has had much experience with geranium oils expressed the opinion that "whilst these oils would not be classed as first grade they would certainly be marketable at a price little below that at which average oil is being sold." It would thus appear that there is some hope for the manufacture of this product locally, if the yield of raw material is satisfactory. Unfortunately the latter is reported to be comparatively low, but with good cultivation and manuring it can no doubt be increased appreciably.

Lime Oil.—Further progress to that reported last year was made with the preparation of hand-pressed and distilled lime oil. Over 11,300 limes were used for the purpose. The yields of oil were found to be much lower than those obtained in the West Indies. The samples of the oils sent to England were, however, reported on very favourably. They were regarded as products of good commercial quality and of about the same value as the corresponding types of West Indian lime oils, which were then quoted as follows: distilled oil 30*s.* per lb.; hand-pressed oil 45*s.* per lb. As oil yield is, however, the deciding factor, it would appear that there is not much prospect of a local industry in lime oil, more so as sufficient limes are at present not available locally except at certain seasons.

Ginger Peel Oil.—The distillation of about 200 lb. of ginger peelings indicated that the oil content of this material was very small (0·055 per cent.) and the operation uneconomic.

Ocimum spp.—The experimental distillation of samples of leaf and flower material of *Ocimum gratissimum* and *Ocimum americanum*, two weeds with characteristic odours commonly found in the district, showed that there was no hope of these plants being utilised commercially. Hardly any oil was obtained with the former and only small amounts with the latter. The chemistry of these oils has already been studied and their constituents found to be such as are more easily and cheaply obtained from other sources.

FIBRES

Cotton

Nigeria.—The report of the Botanical Section, Department of Agriculture (Northern Provinces), for the half-year, July 1 to December 31, 1933, contains the following account of experiments with cotton.

Cotton Seed Disinfection.—An experiment was carried out to determine the effect on yield of disinfecting the seed with a mixture of 1 per cent. Germisan and 0·2 per cent. soap for ten minutes so as to destroy *Bacterium malvacearum.* The disinfectant had an adverse effect on the viability of the seeds so that there was difficulty in getting a stand on the " treated " plots, the final stand being 8·4 per cent. less than the control. Moreover, there was so little bacterial disease on the control plots that it was impossible to distinguish them from the " treated," and it is now evident (December 28) that there will be no increase in yield of treated plots over untreated.

Spinning Test Report.—The lint from two (1932 season) yield trials and from certain other plots was sent to the Empire Cotton Growing Corporation in England in March 1933. Lint of Strain L from three different plots, all within three miles of each other, displayed differences in hair characters and spinning behaviour as follows :

Situation.	Yield of seed cotton per acre	Hair weight per centimetre	Immaturity		Highest count spun	Count × strength
			Per cent Normal	Per cent Dead		
	lb	*mgm* $\times 10^{6}$				
(1) Land cleared of bush in 1932, plus 2 tons per acre of farmyard manure . . .	452	133	38	13	64	2,038
(2) Old land near (1) poor in organic matter, no manure . . .	286	147	46	7	40	2,229
(3) Old land 3 miles from (1) and (2) systematically manured It had 1 ton farmyard manure in 1932 and the cotton was interplanted in millet . . .	304	160	56	6	80	1,642

The appearance of the yarn from (3) was superior to (1) and (2) and the brokers' valuation was higher.

Variety Trial.—The results of a trial of S.G. 27, U4/123 and Allen (seed from Zaria ginnery) were very favourable to S.G. 27 and unfavourable to U4/123, which was found to be generally inferior to Allen. S.G. 27 is a strain isolated by the Agricultural Department in Uganda, and U4/123 is one isolated by the Agricultural Department in Southern Rhodesia. Allen was introduced from Uganda in 1912.

TOBACCO

Ceylon.—The report of Dr. J. C. Hutson, Entomologist to the Department of Agriculture, for the year 1933, contains the following reference to the tobacco stem-borer (*Phthorimæa heliopa*).

This pest was touched upon briefly in the 1932 report, with the indication that the bionomics were being studied further by Mr. de Alwis. The following additional note gives the results of this investigation.

The female moths begin egg-laying within 3 to 8 days after emergence and the oviposition period lasts from 1 to 2 weeks in the case of normally healthy moths. Such moths kept under insectary conditions laid between about 50 and 150 eggs and it was found that they usually laid the great majority of their eggs during two consecutive nights somewhere about the middle of the oviposition period. The small long-oval, soft whitish eggs are laid on either side of the leaves of young seedlings, but more often on the upper surface, and may be seen as minute shiny spots. They hatch in 4–6 days and the larvæ bore inside the leaf and feed as leaf-miners for a day or two. Then they may either enter a side vein and gradually make their way inside the midrib or they may go direct into the midrib. In any case, within about one week after hatching they have passed down inside the leaf-stalk into the main stem, which gradually becomes swollen and stunted unless the plants are making a vigorous growth. As indicated in last year's report, the younger leaves become stunted and bunched together to form a " rosette," and in cases of heavy infestation individual plants fail to develop normally. The caterpillars are full-grown in about 24 to 30 days, but some larvæ may take a few days longer to complete their development. They pupate inside the stem, first leaving only a thin membrane for the emerging moths to break through. In older plants, with fully developed leaves, the larvæ may continue feeding inside the fleshy midribs where they pupate. The pupal period occupies about 10 to 11 days. The life-cycle from egg to moth occupies from 5½ to 7½ weeks under insectary conditions, but may be shorter under field conditions.

The stem-borer can be controlled to a great extent by various mechanical and cultural operations, which include the growing of vigorous seedlings by suitable preparation of the seed beds, the covering of the seed beds, especially at night, with cloth screens, the weeding out and burning of attacked plants in the seed beds and at later stages in the field, the growing of the crop in good soil in rotation with other crops, the application of suitable manures to encourage a vigorous growth from the start, and finally, the removal and burning of the crop refuse after the harvest. If all these measures are carried out as routine practices on tobacco stations and in village areas there should be very little trouble from stem-borer. In any given district only one crop of tobacco should be grown annually, and if all the plants, including any wild plants, are cleared out of the district at the end of the crop, there would be a definite close season during which the pest would be deprived of any breeding places and would find it difficult to carry on from one crop to another as it is able to do in some districts at present. The possibility of wild and cultivated alternative host plants has to be considered, but so far none have been found.

DRUGS

Artemisia spp.

Ceylon.—According to the report of Dr. J. C. Haigh, Economic Botanist to the Department of Agriculture, for the year 1933, a Persian species of Artemisia was grown at the Experiment Station, Peradeniya, on a quarter of an acre, shaded by *Gliricidia sepium* planted 10 ft. apart. Growth was good and the plants flowered freely, but an extraction of the flower buds by the Agricultural Chemist failed to yield santonin ; this result being confirmed by the Imperial Institute. The material was identified by Kew as *Artemisia inodora* M.B.

Material from Northern India, which is also being tried, has been identified as *Artemisia brevifolia* Wall., one of the santonin-bearing species, but it has so far failed to set seed under Peradeniya conditions, and should this failure continue there is little hope of the establishment of an industry unless a regular supply of seed can be assured from outside sources. It is interesting to note that in Northern India this plant flowers and sets seed ; in Ceylon it flowers but does not seed, and in Scotland it does not even flower. Stem cuttings have been taken and successfully rooted, but the percentage of successes is small, and this method of propagation is too uncertain for commercial cultivation.

Kola

Nigeria.—Mr. F. D. Golding, Senior Entomologist, Department of Agriculture, in his report for the half-year, July 1 to December 31, 1933, states that a study was made of the insect pests attacking Kola, and it was found that the most important of these is the weevil, *Balanogastris kolæ* Desbr., which feeds on the nuts. Fallen nuts are heavily infested by these weevils and their larvæ. The effect of collecting and destroying fallen pods each fortnight is being tested. The pods are placed in a fire, as it was found that, when the pods were buried to a depth of one foot in the soil, the weevils were able to tunnel through the soil to the surface.

Weevils of all stages in harvested nuts can be destroyed by the application of paradichlorbenzene ; but there is a tendency for some of the nuts to become discoloured.

RESINS

Lac

Ceylon.—According to the report of Dr. J. C. Hutson, Entomologist to the Department of Agriculture, for 1933, a consignment of three-brooded lac insects which arrived towards the end of January established itself fairly well on masan (*Zizyphus jujuba*), but only produced a moderate brood partly owing to unfavourable weather conditions. This produced a swarm during a very wet period, with the result that most of the young larvæ were destroyed before they could settle down. It has been decided to carry out further experiments in 1934 with the ordinary two-brooded lac, and arrangements have been made to import early in the year a consignment of brood lac on kusum (*Schleichera trijuga*) for inoculating prepared trees of kon, the Ceylon equivalent of kusum. Then in June–July a further consignment of brood lac on ber (*Zizyphus jujuba*) may be imported for inoculating cultivated masan (the Ceylon equivalent of ber) and possibly jungle trees of the same species.

It is not likely that any real progress will be made with lac cultivation in Ceylon until the common host trees of lac insects can be grown on the plantation system, thus enabling the trees to be cultivated and manured regularly and kept down to a reasonable height by periodical prunings. The plantation system of lac cultivation is being developed in parts of India, particularly by the Indian Lac Research Institute, Ranchi, Bihar, to which Mr. Hutson acknowledges his indebtedness for much valuable advice and assistance.

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AGRICULTURE

General

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Watery Whites of Eggs. Report of Preliminary Investigations. By A. S. Canham. *Onderstepoort Journ.* (1933, **1**, 529–566).

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Administration Report of the Madras Fisheries Department for the year 1932–33. Pp. 74, 9¾ × 6½. (Madras: Superintendent, Government Press, 1934.) Price 10 annas.

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Forest Research in India, 1932–33. Part II. Provincial Reports. Pp. 138, 9½ × 6½. (Delhi : Manager of Publications, 1933.) Price Rs. 2 or 3*s*. 6*d*.

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Progress Report on Forest Administration in the Punjab, for the year 1932–33. Pp. 111, 10 × 7. (Lahore : Superintendent, Government Printing, 1934.) Price Rs. 3–12 or 5*s*. 8*d*.

Annual Report of Forest Administration in the United Provinces, for the period April 1, 1932, to March 31, 1933. Pp. 72, 9½ × 6½. (Allahabad : Superintendent, Printing and Stationery, 1933.) Price Rs. 3.

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Deterioration of Structures in Sea-water. Fourteenth (Interim) Report of the Committee of the Institution of Civil Engineers to the Department of Scientific and Industrial Research. Pp. 56, 9½ × 6. (London: H.M. Stationery Office, 1934.) Price 1*s.* 6*d.*

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Timber for Golf Clubs. By J. G. Watson. *Malayan Forester* (1934, **3**, 12–14) With special reference to the use of Malayan timbers.

A note on the Wood Structure of *Acradenia frankliniæ* Kipp. By H. E. Dadswell and A. M. Eckersley. *Journ. Counc. Sci. Indust. Res., Australia* (1934, **7**, 39–42).

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Annual Report of the Indian Lac Research Institute, Namkum, Ranchi, Bihar and Orissa, India, for the year 1932–33. Pp. 39, 9¾ × 7¼. (Namkum, Ranchi, Bihar and Orissa: India Lac Research Institute, 1933.)

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Tanning Materials

Points on Wattle Production. By I. J. Craib. *Bull. No.* 28, *Forestry Dept., Univ. of South Africa.* Pp. 9, 9½ × 6. (Pretoria: Government Printer, 1934.)

NOTICES OF RECENT LITERATURE

Books for review should be addressed to " The Editor," Bulletin of the Imperial Institute, South Kensington, London, S.W.7.

PRINCIPLES OF HUMAN GEOGRAPHY. By Ellsworth Huntington and Sumner W. Cushing. Fourth Edition, Re-written. Pp. xxii + 467, 9 × 6. (New York: John Wiley & Sons, Inc.; London: Chapman & Hall, Ltd., 1934.) Price 18*s.* 6*d.*

This work was first issued in 1921 and a notice of it then appeared in this BULLETIN (1921, **19**, 268), but for the purpose of the present edition it has been largely re-written, new maps have been added, and statistical data brought up to date. Its object, as stated in the Preface, is " first, to set forth the great principles of geography in its human aspects; second, to provide a comprehensive but easily taught textbook for students who have reached an age when they begin to think for themselves; and third, to furnish to normal school students and to teachers in elementary schools a book which will give them a solid grounding in the human relationships which they are eager to teach."

Many readers outside the classes mentioned will find the book suggestive and informative in a high degree, as may be gathered from the titles of the eight parts into which it is divided, viz.: Man's Relation to Physical Environment; Man's Relation to the Earth as a Globe; Man's Relation to Land Forms; Man's Relation to Bodies of Water; Man's Relation to Soil and Minerals; Man's Relation to Climate; Man's Regional Relationships; and Man's Relation to Man. In the various chapters into which these sections are sub-divided the authors have surveyed in a very comprehensive manner the past and present relations of mankind to his surroundings in their various aspects. A wealth of illustrative detail is furnished, and the volume as a whole can be strongly recommended as an illuminating presentation of the wide subject with which it deals.

THE 1820 SETTLERS IN SOUTH AFRICA. A Study in British Colonial Policy. By Isobel Eirlys Edwards, M.A. Royal Empire Society Imperial Studies, No. 9. Pp. 207, 8¾ × 5¾. (London, New York, Toronto: Longmans, Green & Co., 1934.) Price 7*s.* 6*d.*

The author of this book states that its aim " is to examine the origins of the 1820 settlement in South Africa, to explain the breakdown of the scheme, and to discuss the consequences of the comparative failure of the settlement in relation both to the course of events in Cape Colony and to the subsequent development of Colonial policy in Great Britain." The treatise is of a somewhat academic type and likely to appeal only to readers specially interested in Colonial history, but the subject is well presented and copious references are given to the documents on which the work is based. The indeterminate and unsympathetic nature of the Home Government's policy at the time in question is clearly shown, but it is pointed out in the concluding chapter that, by 1826, owing to public agitation in England, " the tide of indifference to colonial questions was beginning to turn " and that the resignation of Lord Bathurst and Lord Charles Somerset " opened the way for the more liberal conceptions of the 'thirties which alone preserved the Second British Empire."

TRANSACTIONS OF THE BOSE RESEARCH INSTITUTE, CALCUTTA. Vol. VIII, 1932–33. Biological and Physical Researches. Edited by Sir Jagadis Chunder Bose, M.A., D.Sc., LL.D., F.R.S., C.S.I., C.I.E. Pp. vi + 266, 8¾ × 5¾. (London, New York and Toronto: Longmans, Green & Co., Ltd., 1934.) Price 21*s*.

This volume contains a number of papers by various authors covering a wide range of subjects.

The opening paper, consisting of an introductory statement, and the second paper on " The Possibility of Differential Effects on Certain Fishes by Water Disturbance and by Vegetable Extracts," are written by Sir J. C. Bose himself. In the latter paper perhaps the most interesting discovery recorded is a means of destroying certain kinds of fish without injuring other kinds. It appears that in the tanks for stocking edible fish near the banks of the Ganges, an objectionable species (*Lates calcarifer*) is introduced when the river overflows its banks. As this fish kills and eats other kinds of fish in the tanks it was considered of importance to discover a method of effecting its destruction. It has been found that a dilute extract of the plant *Cajanus indicus* causes paralysis and death of the *Lates* whilst exerting no harmful effect on other kinds of fish.

Another paper deals with the " Responsive Movements of Leaflets of *Averrhoa* under Strong Light and under Darkness," and this is followed by one on " The Excitatory Impulse in Ordinary Plants," in which evidence is adduced to show that the motor mechanism in sensitive plants is essentially the same as in ordinary plants. The next paper, on "The Effect of External Stimulus on Diametric Growth of Stems," describes a method by which it has been shown that in the case of thin stems light effects a retardation of diametric growth whilst in thick stems a preliminary acceleration occurs which is followed by a retardation.

Other papers describe a method of automatically recording the growth of roots, the effects of certain drugs on plant and animal tissues, and the significance of manganese in plants, this last paper indicating that a sufficient quantity of manganese is one of the factors necessary for the proper functioning of green leaves. There are also a few papers on chemical subjects, and one on the racial affinities of the Mundas, an aboriginal race existing in the hills of Chota Nagpur.

DIE KAKAOKULTUR AN DER GOLDKÜSTE UND IHRE SOZIALGEOGRAPHISCHEN WIRKUNGEN. By Erwin Mai. Pp. 63, 10¼ × 7. (Berlin: Verlag von E. S. Mittler und Sohn, 1934.) Price RM.5.20.

This work, issued as one of the "Veroffentlichungen des Instituts fur Meereskunde an der Universität Berlin," is based on an economic study undertaken with the object of elucidating the factors which have combined in effecting the establishment and extension of cocoa cultivation in the Gold Coast. An attempt has also been made to determine the significance of cocoa production in the industrial life of the country, and a comparison is made between the conditions in the Gold Coast and those prevailing in the two neighbouring producing areas of Nigeria and the Ivory Coast. After discussing the climatic conditions in the Gold Coast attention is given to the configuration of the land and the nature of the soil. An historical account of the industry is supplied together with particulars regarding its organisation and the methods of cultivation practised. Reference is made to the distribution, population, and labour supply, and to the competition of cocoa with other crops, particularly oil-palm products, rubber, coffee, cotton and kola. Methods of transport are discussed and also the influence of the world's markets on the industry. The position of cocoa cultivation in the Gold Coast at certain intervals is shown graphically by means of maps. A useful bibliography is appended.

TROPISCHE UND SUBTROPISCHE WELTWIRTSCHAFTSPFLANZEN, ihre Geschichte, Kultur und volkswirtschaftliche Bedeutung. By Prof. Dr. Andreas Sprecher von Bernegg. Teil III, Band 1: KAKAO UND KOLA. Pp. xi + 264, 10 × 6½. (Stuttgart: Verlag von Ferdinand Enke, 1934.) Price, paper cover, RM.18.70; bound RM.21.

As indicated in the title, this volume deals with cocoa and kola, their history, production and industrial significance. In each case a detailed and useful account is given, including a description of the plant, information regarding the climatic and soil conditions required by the crop, the methods of propagation, cultivation and harvesting, the yields obtainable, the composition of the commercial products, the methods of preparing the crops for the market, and statistics of production and consumption.

In the case of cocoa the position of the industry in each of the producing countries is indicated and particulars are given with reference to the manufacture of chocolate, cocoa powder, cocoa butter and other products.

The book has been carefully compiled, is provided with useful bibliographies, and can be well recommended.

A MANUAL OF THE TIMBERS OF THE WORLD: THEIR CHARACTERISTICS AND USES. By Alexander L. Howard. Revised Edition. Pp. xxiii + 627, 8¾ × 5¾. (London: Macmillan & Co., Ltd., 1934.) Price 36s.

The first edition of Mr. Howard's invaluable book was reviewed in this BULLETIN (1920, **18**, 311). Since that year a remarkable amount of attention has been given to the study and exploitation of timber and to the introduction into the world's markets of timbers new to commerce or comparatively little known, and a considerable number of these novelties have now a more or less definite position in the trade. The present time, therefore, is both convenient and opportune to revise the subject-matter of the first edition and to render the book abreast of the times by the inclusion of accounts of the new recruits to the industry. The author describes his aim as "to supply a clearly arranged handbook which will give information regarding those timbers which have been, or are expected to be, used in works of art or utility."

The general plan of the book remains unchanged except that the sections dealing with specifications and conditions of contract, Laslett's tables of mechanical strengths and the artificial seasoning of timber are omitted. There were useful observations in the first-mentioned section which one is sorry to lose, but the remaining sections will not be missed in view of the abundant information on these subjects which has become available in recent years.

As in the first edition the text is arranged in alphabetical order of the timbers described. The judgment exercised in this apparently simple but really difficult matter deserves commendation, calling as it does for often difficult decisions as to the use of trade, native or botanical names. The alphabetical arrangement, combined with the general index, and indexes to scientific and vernacular names (the latter a new feature), renders consultation of the book easy and complete.

In the new subject matter the author draws special attention to the descriptions of a numerous collection of Brazilian timbers belonging to the late Colonel J. G. Gamble, and other woods imported from Brazil in recent years, of series of Chinese woods (supplied by Mr. J. H. Holland) collected by Professor Chung of Amoy University, and of a number of British home-grown woods.

Due acknowledgments are also made to Prof. Record's *Timbers of Tropical America*, Dr. Foxworthy's publications in the *Philippine Journal of Science* and in *Malayan Forest Records*, and Pearson and Brown's recent *Commercial Timbers of India* ; while reference to the publications of the Imperial Institute are not infrequent.

The result of the author's revision and additions is to render the book indispensable to all interested in timbers and necessary for every general technical library. The first edition, as is inevitable in a work of this kind, presented a number of opportunities for correction, and such were pointed out in the review published in this BULLETIN. These have been dealt with and in general the new edition calls for little except an expression of satisfaction that the subject matter should have been brought abreast of the times.

There is evidence throughout the book that the author has been at pains to keep in touch with the principal developments during the last two decades. His efforts have been very successful, and it is only occasionally that suggestions for improvement can be made. The excellent articles on " Mahogany " should have included a section on Peruvian mahogany which has been marketed in recent years, and the probability that " cherry mahogany " from West Africa is derived from *Mimusops heckelii* Hutch. & Dalz. (syn. *Dumoria heckelii* A. Chev.), and is therefore equivalent to the French West African timber Makoré, might have been mentioned. Abura (*Mitragyna macro-*

phylla Hiern = *M. stipulosa* Kuntze) should have been recorded as a timber of Nigeria and the Gold Coast in addition to "Ivory Coast, Africa," and the Nigerian supplies of Obechi (*Triplochiton scleroxylon* K. Schum.) warrant the inclusion of Nigeria among the countries of origin of this wood. *Pinus caribæa* Morelet should be referred to as slash (not splash) pine and more definite mention of the important stands of the timber in British Honduras might be made in its description.

The opening sentence of the review of the first edition of this work mentioned above may well be repeated here: "Few men can have had the long and varied practical experience of timbers which the author of this book has enjoyed, and the distinctive value of his work is that he has given us the full benefit of his forty years' practical and commercial study." The march of time now permits of a fuller compliment.

La Morìa degli Olmi e la Diffusione in Italia dell' Olmo Siberiano (*Ulmus pumila* L.). By Arturo Ansaloni. Pp. 119, 10 × 7. (Bologna: Edizioni Selva, 1934.)

The rapid spread of the elm disease (*Graphium ulmi*) in European countries in the last few years has made it a matter of importance to settle the question, which has already received considerable attention in the United States, as to the immunity of the Siberian elm (*Ulmus pumila*, L.) to the fungus.

The author of this work is a well-known nurseryman in Italy, where elm trees are largely used as supports in vineyards, as well as for planting along roads. He has taken a considerable amount of trouble, not only in collecting all available information regarding *Ulmus pumila*, but also in initiating practical planting trials in a number of different localities. Saplings imported from the United States were distributed in early spring to nurserymen, private estate owners and public authorities, by whom they were planted, and reports obtained in late autumn showed that in no case was any attack by *Graphium ulmi* found to have occurred, in spite of the fact that in many of the districts the disease was known to be present. The tree was also found to be a rapid grower, and to give equally satisfactory results on various types of soil.

The desirability of growing the Siberian elm to replace other species in Italy being established, the question of the rapid production of saplings in sufficient numbers is of immediate importance. Grafting on to other species of elm has been tried, but is not regarded as a satisfactory procedure, and raising from seed is subject to uncertainties. The author therefore employs a different method, which he describes. Young trees, 1½ to 2 metres high, are bent down and pegged to the ground, and then covered with about 10 centimetres of earth, the branches projecting above the ground. Roots soon appear along the buried tree and the branches develop into fresh saplings. By this means it is possible to obtain as many as ten trees from one, and the author considers that in the hands of a skilled nurseryman the method should be capable of giving a hundredfold increase in a few years.

SOIL ANALYSIS. A HANDBOOK OF PHYSICAL AND CHEMICAL METHODS. By C. Harold Wright, M.A., F.I.C. Pp. viii + 236, 8½ × 5½. (London: Thomas Murby & Co.; New York: D. Van Nostrand Co., Inc., 1934.) Price 12*s*. 6*d*.

During the last few years, rapid development has taken place in both chemical and physical methods for the examination of soils. Many of the older methods have fallen into disuse, while a large number of new ones, often intended to measure properties of soils which were formerly disregarded, have been devised. Descriptions of these new methods, which are to be found in many languages and scattered throughout numerous scientific journals, are here conveniently brought together.

The methods described are grouped under Physical Methods, General Chemical Methods and Special Chemical Methods. Working details are given, as well as references to the original literature. The value of the book would have been enhanced by somewhat more critical selection, as the relative merits of the alternative methods described are not always shown and some of the methods given, particularly in the special chemical section, could be improved in detail. The practical difficulties of technique in some of the physical methods might also have been emphasised more strongly. There are also a few slips, which are usually obvious, such as that on page 183, where one reads that when the chloride ion concentration is both greater and less than 10^{-4}, the quinhydrone electrode forms the positive pole.

The author has undoubtedly carried out a very useful piece of work in bringing together these modern methods in a concise form. The book as a whole gives a good idea of present practice in soil examination, although in view of the rapid developments taking place in the subject in all directions, it seems likely that early revision will become necessary.

METHODEN FÜR DIE UNTERSUCHUNG DES BODENS. By Dr. O. Lemmermann. Teil II. Pp. 122, 9¼ × 6¼. (Berlin: Verlag Chemie, G.m.b.H., 1934.) Price RM.7.50.

Since the publication of the first part of this work in 1932 (see this BULLETIN, 1932, **30**, 395) the consideration of methods of analysis of soils in Germany has been continued by Dr. Lemmermann with the assistance of the same collaborating committee with few changes in personnel. The contents of this volume deal, therefore, both with additional methods of determining the same constituents as those discussed in Part I, and also with methods of making additional determinations, and this accounts for the somewhat disjointed character of the present volume.

The only addition made to the soil-sampling section of Vol. I is a short account of the usual method of taking soil monoliths. The section dealing with the physical examination of the soil contains descriptions of further methods of carrying out mechanical analysis as well as of some of the newer methods for determining physical characteristics such as pore-space and specific permeability.

The chemical section is extended, particularly by the inclusion of details of a considerable number of colorimetric methods of estimating many of the important inorganic elements of the soil, while a few additional methods of estimating nutrient requirements are described.

The two volumes together constitute a useful compilation of the principal methods of examination of soils in use on the Continent and should be of value to all concerned with such work.

A GUIDE TO THE MINING LAW OF SOUTHERN RHODESIA. By H. Bertin, K.C. Pp. 137, 9¾ × 6¼. Second and Revised Edition. (Salisbury: The Rhodesian Printing and Publishing Co., Ltd., 1933.)

This work, of which a second edition now appears, is a compendium of the large number of Ordinances, Acts and Regulations which deal with the mining industry in Southern Rhodesia. It is primarily concerned with the acquisition, tenure and working of gold-reef claims, gold mining being the most important part of the industry in Southern Rhodesia; but there are, in addition, chapters relating to Base Minerals, Oil and Natural Gas, Coal and

Precious Stones. References to a number of judicial decisions are also given. As a guide to a mass of intricate legislation this little book should continue to be welcome to many.

THE PRINCIPLES OF HISTORICAL GEOLOGY. By Richard M. Field. Pp. xii + 283, 9 × 6. (London: Oxford University Press, 1933.) Price 17*s.* 6*d.*

This book is an attempt to simplify the teaching of elementary historical geology by minimising the biological aspects and considering the history of the earth from a regional point of view. It therefore differs completely from the usual textbooks in which a period-by-period treatment is usually followed.

It is divided into two parts, the first of which, consisting of 80 pages, gives a brief outline of the history of stratigraphy, an account of the kinds of sedimentary rocks and their mode of formation, and a discussion of the methods used by stratigraphers for correlating the various formations and deciphering the history of the past.

The second part contains geological descriptions of the Grand Canyon region, the Niagara Falls district, the Appalachians, the North-West Highlands of Scotland, the Alps, and the Yellowstone Park and Big Horn Basin region. These are written in an attractive style and include accounts of scenery and history interspersed with anecdotes and snatches of poetry.

In a pocket on the cover are a number of maps and diagrams illustrating the regions described in the text, together with a rather long list of errata.

The book represents a praiseworthy effort to provide students of historical geology with an introduction to the broader aspects of the subject.

ORE DEPOSITS OF THE WESTERN STATES. Edited by the Committee on the Lindgren Volume. Pp. xxxiv + 797, 9 × 6. (New York: The American Institute of Mining and Metallurgical Engineers, 1933.) Price $5.60.

This volume, which is dedicated to W. Lindgren, the well-known United States economic geologist, is the work of numerous specialists. It is prefaced by an account of the life and scientific work of Lindgren, including a complete and classified bibliography of his scientific writings. Then follow thirteen long chapters, occupying pages 1–784, by some forty-four contributors, all of whom may claim to be regarded as authorities in their respective branches of study.

The contributors include N. L. Bowen, B. S. Butler, W. H. Emmons, C. N. Fenner, J. W. Finch, L. C. Graton, F. L. Hess, D. F. Hewett, F. L. Ransome, R. H. Sales, W. T. Schaller and G. Otis Smith. The book covers a wide range of topics, including the classification of ore deposits, physical-chemical investigation, differentiation and ore deposition, structural geology, relation of ore-deposition to batholiths, correlation of igneous rocks and lodes, supergene enrichment, sedimentary deposits, genetic groups of hypogene deposits, utilisation of geology by mining companies and the history of mining in the Western States.

A copious index concludes the volume, which is printed and published in excellent style, is remarkably good value, and must be regarded as indispensable to anyone interested in the ore deposits of the Western States.

MANUFACTURE OF SODA, with Special Reference to the Ammonia Process. By Te-Pang Hou, Ph.D. Pp. 365, 9 × 6. (New York: The Chemical Catalog Co., Inc., 1933.) Price $8.00.

This book, one of the excellent monograph series of the American Chemical Society, gives a detailed account of the technique of the ammonia-soda process. The author has drawn most of his material from his own experiences, though standard works and scattered articles on the manufacture of soda have been consulted and critically examined.

After a short historical survey, the author deals with the preparation of brine for treatment, the burning of the limestone employed in the process, and the ammoniation and carbonation of the brine. The preparation of sodium carbonate and bicarbonate is considered in detail, and a short account is given of the manufacture of caustic soda. The manufacture of electrolytic soda and by-products is also briefly discussed. Many thermo-chemical calculations and technical details are included, the book being essentially practical in its scope. A useful chapter on chemical analyses and tests in the alkali industry is added.

The book contains much information which has hitherto not been available to those outside the industry, and should be of value to anyone interested, theoretically or practically, in modern methods of soda manufacture.

BOOKS RECEIVED FOR NOTICE

Rural Britain To-day and To-morrow. By James A. S. Watson. Pp. xxiii + 161, 7½ × 5. (Edinburgh and London: Oliver and Boyd, 1934.) Price 5*s*.

Imperial Economy and its Place in the Formation of Economic Doctrine, 1600–1932. By C. R. Fay, M.A., D.Sc. Pp. 151, 7½ × 5. (Oxford: The Clarendon Press; London: Humphrey Milford, Oxford University Press, 1934.) Price 6*s*.

Railways and Roads in Pioneer Development Overseas: A Study of their Comparative Economics. By J. Edwin Holmstrom, B.Sc. (Engineering), Ph.D. (Economics), A.C.G.I., Assoc.M.Inst.C.E., M.I.Struct.E. Pp. 304, 8½ × 5½. (London: P. S. King & Son, Ltd., 1934.) Price 15*s*.

A Text-book of West African Agriculture. Soils and Crops. By F. R. Irvine, D.Sc., F.L.S. Pp. xii + 348, 7½ × 5. (London: Humphrey Milford, Oxford University Press, 1934.) Price 7*s*. 6*d*.

The Vegetable Products of Ceylon. By Frederick Lewis, F.L.S. Pp. vii + 402, 8½ × 5½. (Colombo and London: The Associated Newspapers of Ceylon, Ltd., 1934.) Price 15*s*.

Principales Maladies Parasitaires du Théier et du Caféier en Extrême-Orient. By R. du Pasquier. Pp. 302, 10¾ × 7½. (Hanoi: Imprimerie d'Extrême-Orient, 1933.) Price $10.00.

Termites and Termite Control. A Report to the Termite Investigations Committee. Editor-in-Chief, Charles A. Kofoid, Ph.D., Sc.D. Pp. xxv + 734, 9½ × 6½. (United States of America: University of California Press; Great Britain and Ireland: Cambridge University Press, 1934.) Price 22*s*. 6*d*.

Reptiles of the World. By Raymond L. Ditmars, Litt.D. Pp. xx + 321, 9½ × 6. New Revised Edition. (London: John Lane, The Bodley Head, Ltd., 1933.) Price 18*s*.

The Tariffs on Barley, Oats and Corn. By Theodore W. Schultz, Ph.D. Pp. xvii + 116, 9 × 6. (Madison, Wisconsin: The Tariff Research Committee, 1933.) Price 50 cents.

THE TARIFF ON DAIRY PRODUCTS. By Ronald R. Renne. Pp. 176, 9 × 6. (Madison, Wisconsin: The Tariff Research Committee, 1933.) Price 50 cents.

THE TARIFF ON SUGAR. By Dr. Lippert S. Ellis. Pp. 190, 9 × 6. (Freeport, Ill.: The Rawleigh Foundation, 1933.) Price 50 cents.

DIRECTORY OF PAPER MAKERS OF GREAT BRITAIN AND IRELAND FOR 1934. Pp. xv + 275, 10½ × 7½. (London: Marchant Singer & Co., 1934.) Price 5*s*.

OUTLINES OF PHYSICAL GEOLOGY. By Chester R. Longwell, Adolph Knopf and Richard F. Flint. Pp. v + 356, 9 × 6. (New York: John Wiley & Sons, Inc.; London: Chapman & Hall, Ltd., 1934.) Price 18*s*. 6*d*.

GERMAN-ENGLISH CHEMICAL TERMINOLOGY. An Introduction to Chemistry in English and German. By Alexander King, M Sc, A R.C.S, D.I.C., and Dr. Hans Fromherz. Pp xvii + 324, 8½ × 5½. (London: Thomas Murby & Co.; Leipzig: Max Weg, 1934.) Price 12*s*. 6*d*.

AN ENGLISH BIBLIOGRAPHY OF EXAMINATIONS (1900–1932). By Mary C. Champneys. Pp. xxiv + 140, 9½ × 6½. (London: Macmillan & Co., Ltd., 1934.) Price 5*s*.

IDENTIFICATION OF THE TIMBERS OF TEMPERATE NORTH AMERICA. By Samuel J. Record, M.A., M.F., Sc.D. Pp. ix + 196, 9 × 6. (New York: John Wiley & Sons, Inc; London: Chapman & Hall, Ltd., 1934.) Price 18*s*. 6*d*.

BRITISH GUIANA TIMBERS. By Gerald O. Case, F.S.E. Pp. 73, 8½ × 5½. (London: Metcalfe & Cooper, Ltd., 1934) Price 7*s*. 6*d*.

THE JOURNAL OF THE SOUTH-EASTERN AGRICULTURAL COLLEGE, No. 34, 1934 Edited for the College by S. Graham Brade-Birks, M Sc. (Manc.), D.Sc. (Lond.), F.Z.S. Pp. 274, 10½ × 7½ (Wye, Kent: 1934.) Price 7*s*.

REPORTS OF RECENT INVESTIGATIONS AT THE IMPERIAL INSTITUTE

Selected from the Reports made to the Dominion, Colonial and Indian Governments

PAPER-MAKING TRIALS WITH CONIFEROUS WOODS FROM SOUTHERN RHODESIA

PINUS INSIGNIS, PINUS PATULA AND *CUPRESSUS LUSITANICA*

The three samples of wood which are the subject of this report were forwarded to the Imperial Institute by the High Commissioner for Southern Rhodesia in March 1934. They had been received from the Department of Agriculture at Salisbury.

The woods were examined by the method usually practised at the Imperial Institute, that is to say, determinations were made of the moisture, ash and cellulose present and of the lengths of the ultimate fibres, and pulping trials on a laboratory scale were carried out. In addition, at the request of the Department of Agriculture, the physical and chemical properties of the three woods were determined in accordance with a scheme adopted by the Forest Products Laboratory of the United States Forest Service at Madison, Wisconsin, and described in *Bulletin* No. 6, 1928, of the New Zealand Forest Service ; the results obtained by these methods are appended to the report.

The samples of wood received were as follows :

I. *Pinus insignis* (*P. radiata*).—One barked log, measuring 6 ft. in length and 6 in. in diameter. The wood was of pale cream colour, fairly soft and coarse-grained. Frequent knots occurred throughout the length of the specimen, but there were no signs of stain or exudation of resin.

II. *Pinus patula.*—One barked log, 6 ft. long and 7½ to 8 in. in diameter. The wood was similar in softness, colour and general character to the sample of *P. insignis.*

III. *Cupressus lusitanica.*—One barked log, 6 ft. long and from 5½ to 7½ in. in diameter. The wood was hard, close-grained and somewhat darker than the Pinus woods. The specimen contained many resinous knots, and when sawn emitted a terebinthine odour.

On chemical examination of the samples the following results were obtained :

	Moisture	Ash	Cellulose	
			In wood as received	Expressed on the moisture-free wood
	Per cent	*Per cent*	*Per cent*	*Per cent*
P insignis .	11·8	0·5	54·15	61·4
P patula	12·5	0·2	52·5	60·0
C lusitanica	13·7	0·4	47·55	55·1

The lengths of the ultimate fibres of the woods were found to be as follows :

	Minimum	Maximum	Average
	mm	*mm*	*mm*
P insignis . . .	1·5	4·4	2·92
P patula . . .	1·5	4·1	2·63
C lusitanica . .	1·0	4·2	2·69

For the purpose of pulping trials, representative samples taken from the three logs were reduced to chips, and treated with caustic soda under experimental conditions similar to those employed commercially for the production of pulp by the soda process. The results obtained are given in the table shown on page 345.

The following observations may be made on these results :

I. *Pinus insignis*

Trial A.—The conditions of this digestion were not sufficiently drastic to yield a well-cooked pulp ; as a result a comparatively large proportion of the cooked material was of too hard a nature to yield to the beating treatment, and it was not possible to prepare specimens of paper from the pulp.

—	*Pinus insignis*		*Pinus patula*	*Cupressus lusitanica*
	Trial A.	*Trial B*		
Parts of caustic soda employed per 100 parts of				
Wood . .	20	20	20	20
Solution . .	4	4	4	4
Conditions of digestion:				
Time . *hrs*	5	6	6	6
Temperature °*C*	160	160	160	160
Parts of caustic soda consumed per 100 parts of wood .	10·9	11·0	12·2	11·3
Yield of moisture-free pulp expressed on the wood as received				
Unbleached *per cent*	59·5	59·3	54·0	44·9
Bleached *per cent*	—	52·9	48·3	40·3
Yield of moisture-free pulp expressed on the moisture-free wood				
Unbleached *per cent*	67·5	67·2	61·7	52·0
Bleached *per cent*	—	60·0	55·2	46·7

Trial B.—The longer treatment of the wood in this digestion was just sufficient to yield a strong pulp, which was fairly readily broken down in the beater. The pulp furnished a very tough, opaque, rather bulky, pale brown paper of excellent strength. A small amount of imperfectly disintegrated fibre was, however, observable in the sheets. The pulp did not bleach readily, and a strong bleaching solution was necessary to reduce it even to a pale cream tint. The bleached pulp furnished an opaque paper of similar strength and character to that prepared from the unbleached pulp, but most of the partially disintegrated material had yielded to the bleaching treatment, and only a few particles were apparent in the resulting paper.

II. *Pinus patula*

This material, under the conditions found suitable in Trial B for the *P. insignis* wood, yielded a strong pulp of similar appearance and character to that from the latter. The pulp furnished a very tough, opaque, rather bulky, pale brown paper which was of excellent strength, but contained a similar proportion of imperfectly disintegrated fibre to that in the *P. insignis* paper B.

In this case also a strong bleaching solution was necessary to reduce the colour of the pulp to a pale cream. The bleached pulp furnished an opaque paper of similar strength and character to that prepared from the unbleached pulp.

III. *Cupressus lusitanica*

This wood, under the conditions of treatment employed for *P. patula,* yielded a strong, well-cooked pulp, furnishing a tough, opaque, rather bulky paper of excellent strength. A small quantity of imperfectly disintegrated fibre was present in the finished sheet. The pulp was not easily bleached, even by a strong bleaching solution, and the colour could not be reduced beyond a cream tint. The paper produced was of similar strength and character to that prepared from the unbleached pulp, but was practically free from incompletely disintegrated fibre.

It may be mentioned that in commercial practice the imperfectly disintegrated material, such as that present in the specimens of paper produced in the foregoing laboratory trials, would probably be reduced by the more efficient beating which is possible when working on a larger scale, and would not appear in the finished paper.

The examination of these three woods has shown that they all furnish very good yields of strong, long-fibred pulp under relatively mild experimental conditions of treatment, and with a low consumption of alkali. The pulps obtained furnished papers possessing excellent strength and generally similar in appearance and character, but (as previously observed at the Imperial Institute in the case of pulps obtained from coniferous woods) the pulps were very resistant to the action of bleaching solutions, so that it was not possible to reduce them easily and satisfactorily to a good pale colour. It is probable that by more drastic cooking treatment a whiter product could be obtained, but only at the expense of the yield of pulp.

In actual practice the yields of pulp would be rather lower than those obtained in the present case under experimental conditions, but it is unlikely that they would differ materially from the yields normally found for coniferous woods, i.e. about 45 to 55 per cent. from the oven-dry wood.

New Zealand *P. insignis* wood has been shown in the United States to give good yields of pulp when treated by the principal pulping methods, but when using the acid sulphite process certain unexplainable difficulties were met with in cooking this and woods of similar species.

Judging from the character of the pulps obtained in the present investigation there is little doubt that all three woods would prove suitable for the manufacture of strong kraft wrapping papers, by either the soda or the sulphate process. Further, taking into consideration the appearance and colour of the Pinus woods examined and the fact that the resin contents are low, no difficulty should be experienced in using these woods for making mechanical wood-pulp for newsprint. Owing to its rather dark colour and knotty character the Cupressus wood would be less suitable for this purpose, and it is likely that a rather strongly coloured pulp would result.

APPENDIX

The physical and chemical properties of the three woods, as determined by the scheme mentioned on p. 343, are shown in the following tables.

For comparison with the results obtained for the *Pinus insignis* wood from Southern Rhodesia, the tables include the corresponding figures for wood of the same species from New Zealand as determined at the Imperial Institute and at Madison.

(1) *Major Physical Properties of the Woods*

	Density of oven dry wood *lb. per cubic ft.*	Moisture in sample as received *per cent on oven-dry weight*
Southern Rhodesian samples.		
P insignis . . .	32·8	12·9
P patula . .	28·8	12·8
Cupressus lusitanica . .	34·5	14·9
New Zealand *P insignis*.		
Imperial Institute figures .	29·7	11·7
Madison figures . . .	24·5	—

(2) *Length of Ultimate Fibres*

	Minimum *mm.*	Maximum *mm*	Average. *mm.*
Southern Rhodesian samples.			
P. insignis	1·5	4·4	2·92
P patula	1·5	4·1	2·63
Cupressus lusitanica .	1·0	4·2	2·69
New Zealand *P insignis*.			
Imperial Institute figures	2·0	2·8	2·3
Madison figures . .	1·89	3·78	2·61

(3) *Chemical Examination*

For this purpose four sections, each 2 in. wide, were taken from each log, at different points in its length.

The sections were reduced to chips of the size generally used for pulping experiments at the Imperial Institute, and after thorough mixing a sample was withdrawn, reduced to sawdust and ground to the fineness specified in the Madison method, i.e. material passing a 60-mesh sieve but retained on an 80-mesh sieve. The chemical examination of the ground materials gave the following results, which are expressed in each case on the "oven-dry" wood :

—	Southern Rhodesian samples			New Zealand *P. insignis*	
	P. insignis	*P. patula*	*Cupressus lusitanica*	Imperial Institute figures	Madison figures
	Per cent	*Per cent*	*Per cent*	*Per cent*	*Per cent*
Matter soluble in					
Ether .	0·7	1·1	1·0	0·2	0·8
Alcohol-benzene .	1·5	2·4	2·9	1·7	2·0
Caustic soda solution (1 per cent strength) .	12·7	14·4	15·9	16·4	11·1
Chlorine consumption	34·1	37·2	41·9	38·1	38·1
Lignin . .	26·4	27·6	32·1	28·4	29·6
Cellulose .	61·4	60·0	55·1	57·2	58·9
α-Cellulose . .	37·2	40·8	40·0	37·4	42·9
Pentosans					
In cellulose . .	6·6	5·2	7·0	5·6	5·6
Not in cellulose	7·2	6·8	7·9	6·7	8·5
Total . .	13·8	12·0	14·9	12·3	14·1

Remarks

The results of this examination of *P. insignis* wood from Southern Rhodesia agree closely with those obtained at the Imperial Institute and at Madison with samples of the wood of this species from New Zealand. The figures indicate that the wood, whether grown in New Zealand or Rhodesia, is of similar composition.

The other two species, *P. patula* and *C. lusitanica*, furnished ultimate fibres of about the same length, but the analytical figures obtained for *P. patula* were the more satisfactory. It will be observed that the *P. patula* wood contained less lignin and pentosans and more cellulose than the sample of *C. lusitanica* wood. Both samples furnished good percentages of α-cellulose.

GUMS FROM NIGERIA

In previous numbers of this Bulletin (1910, **8**, 352 ; 1914, **12**, 27 ; 1932, **30**, 12) reports have been published on various kinds of gums produced in Nigeria. During 1933 other samples were received from the Director of Forests in order that the commercial possibilities of the materials might be further explored. The results of the examination of these later samples are given below.

I. *Acacia Verek* Gum from Bornu Province

This material was stated to have been collected from tapped *Acacia Verek* trees in Bornu Province, and was submitted as representing the best type of gum obtainable in Bornu.

The sample consisted of large translucent tears, varying from 2 in. in length by 1½ in. in diameter to 3½ in. in length by 2 in. in diameter. The material was clean, and very little extraneous matter was present. It varied in colour from very pale pinkish-brown to pale reddish-brown, and was somewhat weathered externally. The fracture was vitreous.

The gum was examined with the following results, which are shown in comparison with the corresponding figures obtained for two earlier samples of *Acacia Verek* gum from Bornu Province (this Bulletin, 1932, **30**, 12).

—	Present sample	*Acacia Verek* ("Kolkol") examined in 1931	
		No 1. From tapped trees	No 2 Exudation from untapped trees
Moisture . . . . . *per cent*	15·7	17·7	14·8
Ash . . . . . *per cent*	3·4	3·3	3·3
Matter insoluble in water . *per cent.*	0·3	0·3	0·2
Acid value	3·6	3·4	2·9
Viscosity of a 10 per cent. solution at 20° C.	16·6	12·4	9·5

With the exception of the viscosity the analytical results for the present sample resembled those obtained for the two samples of *A. Verek* gum from Bornu previously examined. The tears were, however, rather larger than those of the earlier samples and somewhat paler in colour.

The gum dissolved readily in water to form an almost colourless solution with good adhesive properties.

The gum was submitted to firms of (*a*) brokers, (*b*) wholesale druggists, and (*c*) confectionery manufacturers, who furnished the following reports :

(*a*) " We find that the quality is of natural sorts, uncleaned, and the pieces are rather unsightly, but it is of quite good average quality. This gum has been shipped from Nigeria to this country, but not in such large pieces. The fact that it is in large pieces does not make much difference, but it is not quite so pleasing to the eye.

" We make the value to be 27*s*. 6*d*. per cwt. (July 1933) ex-wharf London, with the usual London terms, which include 2½ per cent. discount, London landed weights. This works out at about 25*s*. per cwt. c.i.f. London, and no doubt we could obtain this figure on to-day's market for this quality, so long as it could be guaranteed that the quality would not be inferior to the samples you have submitted to us. Quite large quantities could be placed, and once the buyers here were satisfied that the quality could be relied on a very steady business could be developed."

(*b*) " The present market value of Nigerian gum is about 29*s*. per cwt. (August 1933), but the commercial product contains a proportion of dust and small tears, whereas the sample you have sent to us consists of large picked tears. If there is a market for picked tears —but on this point we have no information—the value should be several shillings more than the figure quoted above.

" As you will know, it is Kordofan gum that is used almost exclusively for pharmaceutical purposes, and the price of this gum is now exceptionally low. Cleaned Kordofan sorts is selling at about 31*s*. 6*d*. per cwt. So far as the moisture content and ash limit are concerned, the gum you have sent us conforms with the B.P. requirements, but we find that it produces a somewhat 'glairy' mucilage."

(*c*) " This sample has been examined and found to be clean, pale and of very good taste. In general characteristics it is very similar indeed to gum arabic obtained from the Sudan, although its colour is not quite so light as we should expect from a Sudan gum similarly cleaned from fibre. This gum would be very suitable for confectionery use and so far as we are able to say it would probably be satisfactory also for medicinal use, but we believe that gum bought for medicinal purposes is judged according to the specification in the British Pharmacopœia, which requires that the tears of gum arabic shall be opaque and fissured on the surface. In order to satisfy this requirement the gum submitted would have to be exposed to very drying conditions such as those given in the Sudan by long exposure to the hot sun and dry air. Subject to this, we think that this gum would satisfy the requirements of the Pharmacopœia and be acceptable to the pharmaceutical trade."

" Perhaps we may add that we are importing steadily increasing quantities of gum from Nigeria, the best of which is similar in quality to the samples which you sent.

" As to the value of the gum for confectionery purposes we should take its value at about the same as for cleaned Sudan gum."

II. GUMS FROM YOLA PROVINCE

The two following samples, collected in Yola Province, had been furnished to the Director of Forests by a large trading firm, as representing (1) the best quality of gum purchasable in the area and (2) a second grade which was regarded as being slightly inferior. The firm had stated that about 50 tons of the gum was obtainable annually.

Grade I.—This sample consisted of tears and small fragments. The largest tear measured approximately 2 by 1¼ in. but the majority were much smaller, being generally from ½ to 1 in. in length and ½ to ¾ in. in diameter. The gum possessed a vitreous fracture, varied in colour from almost colourless to pale reddish-brown and was slightly weathered externally. The sample was clean and practically free from extraneous matter.

Grade II.—This sample consisted of tears, fragments and dust. The tears varied from ¾ to 2 in. in length and from ½ to 1½ in. in diameter. The gum was somewhat weathered externally, possessed a vitreous fracture, and varied from almost colourless to pinkish-brown in colour. The sample was clean and practically free from extraneous matter.

The samples were examined with the following results :

		Grade I	Grade II
Moisture	*per cent.*	13·9	13·6
Ash	*per cent.*	2·6	2·7
Matter insoluble in water	*per cent*	0·54	0·26
Acid value		2·2	2·0
Viscosity of a 10 per cent solution at 20° C		8·4	8·6

The above results show that the two samples were of similar quality and that the percentages of ash and matter insoluble in water, and the acid values, were satisfactorily low. Both gums were readily soluble in water, and yielded pale straw-coloured solutions.

The examination of these two grades of gum from Yola indicated that they were of good quality but possessed more colour than the best grades of Sudan gum.

The gum was submitted to a firm of brokers in London, who furnished the following observations :

> " The quality of the samples is very good. The gum is clean and free from dust. A regular business could be done with both these types, the value being 25*s.* per cwt. c.i.f. London terms. There is quite a big trade in this class of gum, and the quantity you mention, 50 tons per annum, should easily be absorbed.
>
> " Care must be taken to see that the quality of the gum is equal to the type samples, both in colour and cleanliness, as at times great difficulty is experienced in gum arabic owing to the presence of very dark pieces and other foreign matter, which necessitates sorting in London. This, of course, brings down the value considerably, and therefore it is in the shippers' interest to pay special attention to the quality of the gums when shipping."

At the date of this report, Sudan gum (Kordofan Natural) was quoted at 32*s.* per cwt. c.i.f. London (August 12, 1933).

III. GUMS FROM NORTHERN PROVINCES

A collection of 65 samples, stated to represent common gums of the Northern Provinces, with the exception of Bornu Province, samples from which had been previously supplied, was forwarded by the Director of Forests in May 1933. The following species were represented in the collection: *Acacia arabica*, *A. campylacantha* (= *A. Catechu*), *A. Seyal*, *A. Sieberiana*, *A. Verek* (= *A. Senegal*), *A.* sp. (? *A. Farnesiana*), *Albizzia Zygia* (= *A. Brownei*), *Anogeissus Schimperi*, *Combretum Kerstingii* (or near sp.), *C. ghasalense* (= *C. verticillatum*), *C. sokodense*, *Entada sudanica*, *Isoberlinia* sp. (? *I. doka*), *Khaya senegalensis*, *K. grandiflora*, *Odina Barteri*, *Pseudocedrela Kotschyi*, *Sclerocarpa birrea* and *Sterculia tomentosa.*

Most of the material proved to be of poor quality and quite unsaleable in this country. A representative of a large firm of gum brokers in London, who inspected the entire collection, regarded six of the samples as being worth considering for export. A description of these is given below, together with the firm's observations on the specimens.

No. 2 F. Acacia campylacantha.—" Niger, Kontagora Dion. No. 6, Karhara." This consisted of fragments and dust of transparent gum, colourless to champagne-coloured; a little bark was present. It was mostly soluble in water, the remainder forming a mucilage. This was the best of five samples from this species, the gum being brighter and lighter in colour, and the sample freer from dark pieces and extraneous matter than the others.

" This is a very fine gum and should be more carefully hand-picked on the other side. In its present condition it is worth 20*s.* per cwt. ex-wharf London, or if it was hand-picked and the few dark pieces taken out it would be worth 22*s.* per cwt. ex-wharf London (October 1933). When collecting this gum care should be taken not to put last season's gum into it, as there are several pieces noticeable in this sample. The quantity of this gum which we could sell would be up to 50 tons per year."

No. 4 A. Acacia Sieberiana.—"Sokoto (7), Farin Kaya." This consisted mostly of fragments and dust. It was transparent, colourless to orange-red, with a little bark present. Soluble in water.

" This gum has distinct possibilities, but same must be hand-picked and the dark pieces, bark and last year's gum taken out, otherwise it is quite a good gum. It should prove a true competitor to Talha (Sudan Gum) which is worth 11*s.* per cwt. c.i.f. and 12*s.* 6*d.* to 13*s.* per cwt. ex-wharf London. About 100 tons per annum could be sold of this gum."

No. 4 *C. Acacia Sieberiana.*—" Bauchi Division, No. 5, Farin Kaya." Fragments and dust of transparent, very pale to pale straw-yellow gum of fairly uniform colour. A little bark was present. Mostly soluble in water, the remainder forming a mucilage.

" The same remarks to a certain extent apply to this sample as to sample No. 2 F, only the gum is not so bright, and therefore we make the value about 2*s.* per cwt. lower than No. 2 F."

No. 4 *C. Acacia Sieberiana.*—" Gum (Karo) Jaran Kaya. Locality: Katagum, Bauchi." Fragments and dust of transparent, colourless to orange-red gum. Some bark present. The gum was mostly soluble in water, the remainder forming a mucilage.

" The same remarks apply to this gum as those concerning 4 A, but there are larger quantities of dust and small in this sample, which brings the value down to about 9*s.* c.i.f. and 10*s.* spot. Although this is a dusty gum it does not contain dirt or sand, and care should be taken that shipments do not contain dust other than gum."

No. 9 *B. Anogeissus Schimperi.*—" Adamawa, Muri Diva, Marica No. 8." This sample consisted of conglomerates, fragments and dust. The gum was transparent but mostly dull, with some pieces opaque; almost colourless to golden brown. Some bark present. Semi-soluble in water, swelling to a mucilaginous mass.

" This is an unknown gum and is very watery, and we are practically sure is not of commercial value. The sample contains two qualities of gum. One is soluble and one is not soluble, or it may be more probable that one has been collected in the wet season and one the dry season. We are practically sure that the wet-season gum is unmarketable. Regarding the merchantable portion of this gum, which can be recognised by the brightness, if sufficiently large quantities could be collected we could undertake to have laboratory tests made."

No. 24 *C. Khaya senegalensis.*—" Bauchi." This consisted of conglomerates, vermiform fragments and dust; semi-transparent and very pale greenish-yellow to golden-yellow in colour. Some bark present. Semi-soluble in water, swelling to a mucilaginous mass. Gum represented by this sample, and by four other samples from the same species, would be mostly unsaleable on account of colour, but in some cases there were a few lighter-coloured pieces which would be marketable.

"If the better quality of this gum could be obtained, representing the white pieces in this sample, this would be interesting, but it would be necessary to collect this only in the dry season."

It will be seen that only one of the samples would be saleable in its present condition, viz. 2 F (*Acacia campylacantha*). Several others would be saleable if freed from dark and old gum, and from extraneous matter such as bark. It would not be economic to carry out this cleaning in London, as the cost of so doing would not allow a price to be paid for the crude gum that would be remunerative to the collectors. Other samples contained small portions of saleable gum, suggesting that the bulk of the gum was old material and that possibly the fresh gum, carefully collected, would have a better appearance.

It is therefore apparent that the collection of samples as a whole consisted of very poor material, and there is much room for improvement in collection and marketing. It may be taken as a guide that only bright-looking gum of the palest colour, clean and free from bark and dirt, is likely to find a market in Europe.

The results of the solubility tests which were carried out are further evidence that the material in many of the samples was of variable age, or not entirely of one variety. For instance the sample of *Anogeissus Schimperi* (No. 9 B), dealt with above, was soluble whilst another sample was semi-soluble.

It has been suggested to the Director of Forestry that information should be furnished to the Imperial Institute as to the possibility of collecting in suitable condition commercial consignments of the gums in the present collection which are considered likely to be saleable in London.

It was further pointed out that if trial shipments of any of the materials are forwarded to test the market the Imperial Institute will be glad, if so desired, to assist in their disposal.

ECONOMIC PRODUCTS FROM BRITISH HONDURAS

In connection with the article on the Resources of British Honduras appearing on pages 376-410 of this Bulletin, it was thought it would be of interest to publish the reports on the various products which had been received at the Imperial Institute from that Colony in recent years, or which had been the subject of special enquiry. Other products have been dealt with in earlier issues of this Bulletin, including the following: Cohune nuts, 1903, **1**, 25; 1913, **11**, 226 (reprinted 1914, **12**, 23); tobacco, 1906, **4**, 198; mangrove bark, 1907, **5**, 344; cocoa, 1908, **6**, 84; kapok, 1913, **11**, 81; sword beans (*Canavalia* sp.), 1913, **11**, 242; Cauto cotton, 1916, **14**, 591; sisal hemp, 1917, **15**, 486; henequen, 1919, **17**, 481; *Paspalum conjugatum* grass, 1928, **26**, 296.

Secondary Timbers

As pointed out in the article on p. 376, the principal timber exploited in British Honduras is mahogany, but a number of other useful woods occur in the colony, some of which, like rosewood and cedar, are already known in the trade, whilst a few others have also already been exported in small quantities (see p. 397). With a view to ascertaining the value of some of these secondary timbers, logs of fourteen different kinds were forwarded to the Imperial Institute some years ago and their mechanical and working properties determined, whilst the Institute's Advisory Committee on Timbers reported on their commercial possibilities in this country. Subsequently a sample of the local balsa or polak wood was similarly dealt with and paper-making trials with some of the woods were carried out. The reports on these investigations will be found in the following issues of this Bulletin:

Vol. XXI (1923), No. 4, pp. 569–581: Banak (*Virola merendonis* Pittier); Santa Maria (*Calophyllum brasiliense* var. *Rekoi* Standl. = *C. Calaba* Auct. non Jacq.); Salmwood (*Cordia alliaria* Cham.) and Black Poisonwood (*Metopium Brownei* Urb.).

Vol. XXII (1924), No. 1, pp. 1–14: Bullet Tree (*Bucida Buceras* L.); Nargusta (*Terminalia obovata* Steud.); Pine (*Pinus caribœa* Mor.); Tubroos (*Enterolobium cyclocarpum* Gris.).

Vol. XXII (1924), No. 4, pp. 397–413: Waika Chewstick (*Symphonia globulifera* L. f.); Quamwood (*Schizolobium Kellermanii* Pittier); Cottonwood (*Ceiba pentandra* Gaertn.); White Moho (*Belotia Campbellii* Sprague); Cypress (*Podocarpus coriaceus* L. C. Rich.); Sapodilla (*Achras Sapota* L.).

Vol. XXIII (1925), No. 1, pp. 4–8: Balsa Wood or Polak (*Ochroma bicolor* Rowlee).

Vol. XXIII (1925), No. 1, pp. 12–17: Paper-making trials with Quamwood, White Moho and Polak.

The Imperial Institute has continued to keep in close touch with the Forest Department in connection with the development of British Honduras timbers and quite recently questions relating to the utilisation in this country of rosewood and balsa wood have been dealt with. A summary of the particulars furnished to the Department in respect of these two timbers is given below.

Rosewood

Early in 1933 the Conservator of Forests consulted the Imperial Institute as to the possible demand in the United Kingdom for British Honduras rosewood (*Dalbergia Stevensonii* Standl.). He states that the tree grows in a restricted swamp area in the south of the Colony and production will always be limited. Without actual cruising figures it is difficult to say what the maximum sustained yield would be, but it is estimated that a minimum of 500 tons could be exported annually.

The matter was referred to the Imperial Institute Advisory Committee on Timbers, who considered that, on account of the prevailing lack of interest in rosewood generally among the public, the prospects of British Honduras rosewood (which is admitted to be an excellent timber of its class) in this market for furniture and decorative work are not promising. For these purposes the timber with others has been ousted by walnut, and there would seem to be little chance of rosewood regaining popularity at present. The other uses of rosewood (Bahia and East Indian sorts, for example), while not negligible, are not extensive, and it would not be desirable to rely upon such outlets for absorbing any considerable quantities of the British Honduras wood.

In order, however, to test the market definitely in different directions, the Imperial Institute has arranged for the Forest Department to send over samples of the various types of logs at present available for shipment.

It was stated by one member of the Advisory Committee (a furniture manufacturer) that an objection to most rosewoods in his trade is a tendency to " sweat " after treatment with the spirit varnishes ordinarily used for finishing woods. He believed that, if this difficulty could be overcome, rosewood (including the British Honduras wood) might well find a certain outlet in decorative construction work. Trials are now in progress in order to ascertain whether a modern cellulose varnish will give satisfactory results. The Department have also been furnished with a detailed statement as to the various methods in use for finishing hardwoods, with special reference to the rosewood problem.

Balsa Wood

The Conservator of Forests informed the Imperial Institute that Balsa (*Ochroma bicolor* Rowlee), yielding a timber of unusually light weight, and with valuable insulating properties, grows readily on abandoned cultivations in British Honduras and could be made a successful plantation crop. Before starting plantations, however, it would be necessary to have some data as to market requirements in order to plan the rotation, and the Imperial Institute were consulted on this aspect of the question. The following statement incorporates the information which was duly furnished.

Hitherto, the trade in Balsa wood in the United Kingdom has been comparatively small ; the principal outlet has been for heat insulation purposes. The timber has been handled by three different sections of the trade, viz. (*a*) by a specialist firm of importers, (*b*) by brokers and (*c*) by hard-wood timber merchants, and firms in each of these categories were consulted in order to obtain as complete a view as possible of the present position and future prospects of the wood in this market.

(*a*) The firm of importers state that the timber sold by them is in two grades or qualities, viz. a very light-weight grade and a harder grade. The bulk of the business is done in the very lightest timber, which is required for insulating purposes. The firm import the timber from Ecuador in the form of planks from 6 ft. to 20 ft. in length, 6 in. to 22 in. in width and 1 in. to 5 in. thick, every plank free from the " brown core," which defect, it is stated, may give rise to a very great amount of trouble.

The Company consider that there should be a good market for British Honduras balsa wood provided that the c.i.f. price is competitive with that of cork slab, which is probably the most important alternative to balsa for insulating work. They would be interested in buying supplies from British Honduras provided that the timber is of a quality equal to or better than that already imported by them from Ecuador, and is offered in the form and sizes mentioned above and weighs when dry about 7 lb. to 8 lb. per cubic ft. at the most. As a purely tentative figure for first-grade wood the firm suggests 3*s*. to 3*s*. 6*d*. per cubic ft. landed in the United Kingdom.

The firm remark that they understand that the Ecuador balsa wood imported by them is derived from *Ochroma Lagopus* Sw., and not from *Ochroma bicolor* Rowlee, the source of the British Honduras wood.

(*b*) The brokers consulted state that balsa is an excellent material for the purposes to which it has been applied, but the timber trade in this country at present takes little or no interest in the wood ; it is of course not possible to say what would be the position at such time hence as supplies from the proposed plantations in British Honduras would be available. The principal market for balsa is in the United States, where it is extensively used for refrigerator linings and for making pads and braces to place inside shipping crates to prevent breakage or the marring of polished surfaces of high-class furniture and cabinet work. The chief outlet is probably in refrigerator manufacture, and the difference of climatic conditions in this country is probably responsible in considerable measure for the restricted use of balsa here.

Owing to the lack of general demand in the United Kingdom the English trade has established no standard specifications for balsa, but in the American market the standard thicknesses required are 2 in., 3 in. and 4 in.; 2½ in. is also obtainable. The widths are usually 4 in. and up, averaging say 6 in. to 7 in., and the lengths range from 4 ft. to 14 ft., averaging about 8 ft. The wood is classed as Grade "A," which permits the usual balsa wood defects such as occasional pith and pin worm-holes. For planks free from these defects, in the rough, kiln dried, a considerably better price is required, probably about 50 per cent. higher.

The firm had not received any recent indications as to values (price), but mentioned that a few months ago one of the principal sellers in the United States quoted 10½ cents for Grade "A" wood, c.i.f., and 15½ cents for the planks free from defects.

(*c*) An important firm of timber merchants considered that balsa in the United Kingdom is still in the experimental stage. The firm are also important veneer merchants, and state that they are anxious to obtain a very light wood for rotary veneer cutting for plywood manufacture, but the balsa wood which hitherto has been submitted to them in this connection has been of indifferent quality, having the appearance of being "over-grown, or the trees after felling having been left around with the result that the logs became stainy and decayed before shipment."

The senior partner in the firm states, before offering an opinion as to the advisability of making special plantations of balsa in British Honduras, he would be glad to test a few butt lengths of "really freshly felled healthy trees," as would be forthcoming from such plantations; such trees to be selected as avoiding the defects above mentioned, and also for cleanness, and to furnish butt lengths 14 in. to 20 in. diameter and 6 ft. to 8 ft. long. The firm would willingly test such logs for their purposes and submit a report.

Reviewing the opinions obtained it would seem clear that the demand for balsa wood in this country at the present time is comparatively small and that there is no indication of development in the near future. It was suggested to the Forestry Department, however, that the offer made by the firm of merchants would appear to be worth consideration, and that it would also seem desirable to submit representative samples to the firm of importers who were consulted.

CROWN GUM

As mentioned on page 398 of this BULLETIN, an inferior chicle-like product, known as Crown Gum, is collected in the southern half of British Honduras. The identity of the tree or trees yielding it is not known with certainty, but it is probably derived chiefly from *Achras Chicle*. The Conservator of Forests informs the Imperial Institute that Crown gum requires considerably more cleaning and preparation than the true chicle and that it is more brittle and rubber-like. He states that it has been used on the Continent for various purposes, including the insulation of marine cables. In order to investigate the possible uses of the material, a sample was forwarded by the Conservator of Forests in March 1933.

The sample consisted of a block of friable material, pinkish-brown externally and pinkish-white in the middle. It softened on working with the fingers and became pliable; at 100° C. it became soft and tacky.

On washing, the material as received lost 8·7 per cent. of its weight. A portion of the sample after washing was examined with the following results, which are shown in comparison with recorded figures for chicle:

	Present sample *Per cent*	Chicle. *Per cent*
Moisture	28·5	35·0
Crude proteins	1·4	0·6
Matter soluble in acetone (resins)	47·9	40·0
" Gutta," etc. (by difference)	21·2	17·4
Ash	1·0	4·7
Sand and other foreign matter	—	2·3

The gutta (i.e. the portion insoluble in acetone) was pale pink and friable. At 100° C. it was soft and tacky, but it regained its hardness and friability on cooling. The resins were golden-brown and hard.

A portion of the washed and dried material was mixed with smoked sheet rubber in the proportion of 10 parts of Crown gum to 100 parts of rubber, in order to determine its effect on the plasticising properties of rubber. After passing through the mixing rolls 90 times the plasticity of the smoked sheet was 0·15 and that of the mixture 0·21. The Crown gum therefore had a softening influence, but the effect was not sufficiently marked to render the material of interest to rubber manufacturers. In addition, the Crown gum was difficult to manipulate owing to its sticky character when warmed.

With a view to ascertaining the suitability of Crown gum for use in the insulation of cables, the material was submitted to two large firms of cable manufacturers in the United Kingdom, who reported on it as follows :

(1) " We have examined the Crown gum and find that the material is a low-grade gum closely resembling gum chicle in analysis and properties, but not in colour, for chicle is usually of a pinkish-cream tint. It has no value alone as an insulator for marine cables, and could only be used as a diluent of good-quality materials for this purpose. We should consider its probable commercial value of the order of 3*d.* or 4*d.* per lb."

(2) " Our opinion of the possible use and value of this Crown gum is as follows :

" In its crude form it is a similar product to ' Borneo Sheet,' ' Accra Paste,' and ' Pontianac Gum,' and has appeared on the market at various times. In colour it is a greyish-white material, changing to reddish-pink from the outside inwards, owing to oxidation and a gradual drying out of the moisture content, which varies from the outside crust (1·18 per cent.) to the interior portion (32·39 per cent.), while the sample of (air-dried) washed material has a moisture content of 9·38 per cent.

" The crude gum contains much fibre and dirt, which can be removed by washing.

" Its characteristic properties lie in its similarity to gutta-percha or balata, but actually it is an inferior product to either. It is thermo-plastic at very low temperatures, and, owing to its high resin content, is not suitable as an insulant for lighting and power cables. It might be serviceable as a cheapening admixture to higher quality gutta-percha for use as an insulant for submarine telegraph cables, but this is doubtful, and we do not manufacture this type of cable.

" We believe it might be commercially valuable in the washed condition, provided it can be marketed at a price similar to that of raw rubber, especially for the purpose of making adhesive insulating tapes, thermo-plastic cements, or filling compositions for sealing purposes, where it could be mixed with other suitable materials. It has, however, no value of any kind as an ingredient to enter into the composition of an insulant to be applied to conductors for electric lighting or power purposes, such as those with which we are solely concerned.

" In conclusion, we might add that we think it necessary that this material should be marketed only in a washed form, so that the washing process could be carried out by native labour in order to reduce costs. Such material might be tried out for making adhesive bitumen tape, etc., but we have not sufficient to carry out experiments. Even for this purpose, however, the market price would, of necessity, have to be quite low, and we suggest a price of not more than 3*d.* or 4*d.* per lb."

From the results of the examination of this Crown gum and the opinions of cable manufacturers, it will be seen that the product is unsuitable for use as an insulating material, but that it might find an outlet in the United Kingdom at a low price for certain technical purposes.

The possibility of employing the material for the manufacture of chewing-gum was also investigated. Preliminary trials carried out by a firm of manufacturers in the United Kingdom seemed to indicate that it was of a promising nature for this purpose, but more extended tests, with a further quantity received in October 1933, were less satisfactory. It was found that the material was quite unsuitable for use alone as a gum base, because the product obtained in the course of manufacture is quite fluid and cannot be worked in the shaping machines. Mixed with a proprietary base in the proportion of 1 : 4 and 2 : 3 it produces a residue which is much too soft and sticky, and in this respect far inferior to true chicle. It was thought that 5–10 per cent. might possibly be used in cheaper grades of chewing-gum if the price of Crown gum is sufficiently low, but experimental mixings would be necessary to decide this.

OLEO-RESIN OF *PROTIUM* SP.

The sample of oleo-resin which is the subject of this report was forwarded to the Imperial Institute by the Conservator of Forests in March 1933. It was stated to represent material collected on a small scale from a species of *Protium* by the Maya Indians for use locally as incense, but it was considered that it could be obtained in quantity if a commercial outlet could be found for it.

The sample consisted of an irregular lump of opaque, pale yellow oleo-resin, possessing an odour of turpentine and also of lemon. The material was rather soft externally and very soft and sticky within. A small amount of vegetable debris was present.

The material as received had the following composition :

	Per cent
Moisture	5·2
Volatile oil	11·0
Resin[1] (by difference)	83·3
Matter insoluble in ether (dirt)	0·5

[1] *Portion soluble in ether, less volatile oil and moisture*

Further examination of the original material furnished the following figures, which are given in comparison with those recorded for Manila elemi, the product of *Canarium luzonicum* :

		Present sample	Soft Manila Elemi	Hard Manila Elemi
Ash	*per cent*	0·02	0·02 to 0·2	0·2 to 1·0
Acid value		28·4	17 to 25	15 to 28
Ester value		13·7	7 to 25	25 to 35

The volatile oil obtained from the oleo-resin by steam distillation was found to have the following constants, which are given in comparison with figures recorded for the volatile oil from Manila elemi:

	Present oil	Oil from Manila Elemi
Specific gravity at 15·5°/15·5° C	0·8691	0·870 to 0·915
Optical rotation α_D . .	−48·7° at 24° C	+ 30° to + 55°
Refractive index n . . .	1·4760	1·4775 to 1·490
Acid value	1·7	0·0 to 2·0
Ester value . . .	18·1	4 to 10
Solubility in 80 per cent alcohol at 15·5° C	Soluble in 16 vols with slight turbidity	

The initial boiling-point of the volatile oil from the *Protium* oleo-resin was about 155° C., but the bulk of the oil distilled over between 170° and 178° C. The oil appeared to consist largely of phellandrene, the presence of which was confirmed by the preparation of the nitroso-compound.

The resin left after the removal of the volatile oil was freed from extraneous matter by solution in ether (in which it was readily soluble) and filtering. After removal of the solvent the purified resin was transparent, pale yellowish-brown, and of about the same hardness and brittleness as ordinary rosin (colophony).

The purified resin furnished the following constants, which are shown in comparison with the figures recorded for commercial rosin:

	Present Resin	Commercial Rosin
Acid value (direct)	31·1	150 to 175
Saponification value	43·3	175 to 195
Softening point	90° to 95° C	70° to 80° C
Melting point	117° C	100° to 135° C

The solubility of the resin in various solvents was found to be as follows:

Acetone	Completely soluble
Alcohol	Almost entirely soluble
Benzene	Completely soluble
Chloroform	do
Ether	do.
Light petroleum	Partly soluble
Turpentine oil	Completely soluble
Linseed oil	do.

The original oleo-resin was compared with commercial gum olibanum to ascertain its possible utility as an incense gum. The test was carried out on glowing charcoal in an incense burner. The aroma was devoid of the aromatic fragrance of gum olibanum, and though not unpleasant was not of sufficiently attractive character to render the resin worth consideration as an incense gum for the United Kingdom market.

The material was submitted to merchants in London who furnished the following report:

> " We have fully examined this sample and compared it with Manila elemi, finding it to be almost if not quite equal for the usual applications of this oleo-resin. Accordingly we are quite prepared to import a small trial shipment, say of 25 cases, and we could pay the price of 44*s.* per cwt. c.i.f. London. This compares with the present market value of 45*s.* for Manila elemi.
>
> " For your guidance we may state that the latter oleo-resin is packed in cases containing two gasoline tins each containing 40 lb. net, the total weight being therefore 80 lb."

The firm mentioned that they usually import Manila elemi in lots of 50 cases at a time, but they are prepared to receive 25 cases in the present instance to start the trade.

The results of examination have shown that the present material is an oleo-resin of a somewhat plastic and aromatic nature resembling Manila elemi. It will be observed that the constants of the oleo-resin, and the characters and composition of the volatile oil distilled from it, are generally similar to those recorded for Manila elemi, although the volatile oil from the present material was lævo-rotatory whereas the oil from Manila elemi is dextro-rotatory.

In view of the fact that this oleo-resin could be utilised commercially for the same purposes as Manila elemi, the Imperial Institute enquired of the Conservator of Forests whether the trial shipment asked for by the merchants, packed in the manner suggested, could be forwarded to London, and also as to the quantity which could be supplied annually if a regular demand should ensue.

In reply it was pointed out that the price of 44*s.* per cwt. offered by the London merchants is equivalent to $220 per ton at the present rate of exchange. Deducting the cost of ocean freight from Belize to London ($17 per ton) and of coastal freights from the producing centres to Belize ($2 per ton) leaves a net return of $201 per ton or 9 cents per lb. Cost of transport from the forest to riverside will average ¾ cents per lb., shipper's commission 1 cent, sub-contractor's commission 1 cent and Crown royalty ½ to 1 cent, leaving approximately 5–6 cents per lb. for the tapper. The tapping of the resin is as difficult as chicle-bleeding, for which prices have been until 1933 12–16 cents per lb., and, even at the extremely low wages prevailing at the end of that year, not less than 8 cents. No firm, therefore, would be prepared to ship the resin at the current prices.

At present tappers obtain some 40 to 50 cents per lb. for limited quantities of the resin for use as incense in churches, and it would be preferable for the tappers to continue on these lines rather than to go in for tapping on a large scale at unremunerative rates. The Forest Department further point out that it would appear to be politic to preserve the existing stocks of *Protium* tree from heavy tapping until such time as improved tapping methods, alternative markets or better prices, enable the local producer to enter the world markets at economic prices.

With remunerative prices it is estimated that an export to the extent of at least 100,000 lb. per annum could be worked up.

Cohune Palm Fibre

A specimen of the fruit stalk of the cohune palm was furnished to the Imperial Institute by Mr. H. C. Sampson, Economic Botanist, Royal Botanic Gardens, Kew, in November 1928. It was stated that large quantities of these stalks could be obtained if they were likely to be of value for export to the United Kingdom for brush-making or other purposes.

The sample consisted of a very fibrous stalk about 3 ft. long. For a length of about 1 ft. 9 in. the stalk had been opened up, and separated into long, clean, straight strands of fibre, thus forming a " whisk " of which the rest of the stalk constituted a handle and tapered to a hard, wood-like point between ½ in. and ¾ in. in diameter.

The strands of fibre were about $\frac{1}{50}$ in. in diameter, pale brown, smooth and of fair lustre. They were not very strong, but were fairly flexible and could be tied into knots without breaking. From a brush-making point of view the fibre was of satisfactory length, but it was deficient in resilience as compared with brush-making materials of good quality. It appeared likely, however, to be suitable for the manufacture of cheap soft brushes and brooms.

The sample was submitted to merchants and manufacturers in London, who furnished the following observations:

(1) The merchants stated that for shipment to the United Kingdom the fibre would have to be separated from the hard, woody portion of the stalk. They were of opinion that the fibre could undoubtedly be used in brush manufacture, and that if preliminary shipments showed that it would be acceptable on the market the price obtainable might fall between those of coir bristle and Mexican (or " Istle ") fibre, that is, in the neighbourhood of £25–£30 per ton in London (January 1929).

The firm stated that the fibre was very clean, well prepared and of satisfactory length, although as regards the last point, they mentioned that, whilst even shorter fibre would be saleable, longer fibre would have an advantage from a manufacturer's point of view as it would entail less waste when cut up for brush-making.

They stated that for shipment the fibre should be tied in small bundles, from 4 to 5 in. in diameter, which should be trimmed off level at the ends and packed in bales for export. If a trial consignment of half a ton could be forwarded they would be glad to submit samples to the principal users of such materials.

(2) The manufacturers also reported that the fibre (after being separated from the stalk) would be suitable for brush-making, stating that it has the advantage of being a light, bulky fibre, but that on account of its lack of resiliency it would have to be employed in admixture with more resilient materials. They advised that fibre for shipment should be made up into bundles about 3 in. in diameter, each fastened with two or three ties; all the

fibres should be as long as possible and (contrary to the suggestion of the merchants mentioned above) no trimming should be carried out. The bundles should be pressed-packed into bales of about 4 cwt. each. The firm were not able to assign any definite value to the material, but said that it would be classed as a brush-making fibre of comparatively low grade.

It will be seen that this cohune palm fibre, if separated completely from the stalk and suitably packed, should be saleable in the United Kingdom, but that its value on the market could only be determined by the forwarding of actual shipments.

"WILD PLANTAIN" FIBRE

The sample of fibre which is the subject of this report was submitted to the Imperial Institute by Mr. H. C. Sampson in November 1928. Mr. Sampson stated that the material was derived from the leaf-sheath or pseudostem of a plant similar to *Musa* spp., but not belonging to that genus. He described it as "a giant *Heliconia*, growing to a height of 12 to 15 ft., at present unidentified."

The sample consisted of fibre about 4 ft in length, generally well-cleaned and prepared, though not very lustrous. The strands were of about the same thickness as the finer or better grades of Manila hemp. The strength was somewhat variable, but on the whole fairly good, though inferior to that of good samples of Manila hemp of the same thickness.

The sample was insufficient for chemical examination.

On microscopical examination the ultimate fibres were seen to possess a very well-defined lumen which varied considerably in diameter, being sometimes much wider and at other times narrower than the fibre walls. The ends of the fibres were fairly sharply pointed, the lumen generally extending almost to the tips. The ultimate fibres had the following dimensions :

	Length. *mm.*	Diameter. *mm.*
Maximum	9	0·0279
Minimum	3	0·0127
Average	5	0·0178

The microscopic appearance of the ultimate fibres was not altogether unlike that of the fibres of *Musa* spp., but the dimensions quoted above show that they were slightly shorter and narrower than those of *Musa textilis* and longer and narrower than those of banana fibre (*M. sapientum*).

The fibre, if offered in commercial quantities, would find a market for cordage manufacture, but before a definite value could be assigned to it a larger sample would be required for examination and submission to the trade.

CASSAVA PRODUCTS

In view of enquiries which had been received as to the possibility of obtaining cassava starch from Empire sources, the Imperial Institute communicated in July 1927 with the authorities in British Honduras, where cassava is grown as a local foodstuff, particularly in the Stann Creek area. As a result, samples of both cassava starch and dried cassava roots (chips) were received in January 1928, with a view to ascertaining their commercial value in the United Kingdom.

In all, five samples were received at the Imperial Institute ; three of them were unlabelled, but from information furnished by the Colonial Secretary the specimens were apparently as follows :

(*a*) Unlabelled, but assumed to be " *Dried Sweet Cassava Chips.*" Slices of scraped cassava roots, mostly of a creamy-white colour but in some cases showing a brown tinge externally.

(*b*) Unlabelled, but assumed to be " *Dried Bitter Cassava Chips.*" Slices of scraped roots, similar to the foregoing sample, but of a rather browner tint.

(*c*) Sample labelled " *Stann Creek Sweet Cassava Starch.*" Cassava starch, in the form partly of a white powder and partly of small lumps of a creamy tint.

(*d*) Sample also labelled " *Stann Creek Sweet Cassava Starch.*" Similar to the foregoing sample of starch, but of rather better colour.

(*e*) A very small unlabelled sample, consisting of a fine buff-coloured meal resembling ground cassava root. This fifth sample was described in the Colonial Secretary's letter as " specially prepared starch from the refuse of starch previously made."

Samples (*c*) and (*d*) in the above list were, as stated, both labelled " sweet cassava starch," but from the particulars furnished by the Colonial Secretary it would appear that one was intended to represent " bitter " cassava.

Sliced Roots. The two samples (*a*) and (*b*) of this material were analysed with the following results, which are shown in comparison with the range of corresponding figures previously recorded at the Imperial Institute for samples of cassava roots from various sources :

—	British Honduras samples		Cassava roots from various sources
	(*a*)	(*b*)	
	Per cent	*Per cent*	*Per cent*
Moisture	12 3	12 1	10 1–12 7
Crude proteins	1 0	1 0	1 1–3 8
Starch (by acid hydrolysis)	71 6	70 3	62 1–77 5
Crude fibre	1 9	2 2	1 3 3 0
Ash	1 7	1 9	1 0–1 4
Prussic acid	0 0006	0 0012	0 0008–0 0022

The results show that the present samples were of normal composition.

With reference to the amount of prussic acid present, it will be observed that sample (*b*) contained twice as much of this constituent as (*a*), thus confirming the assumption that sample (*b*) is the " bitter " cassava.

Starch.—The two samples (*c*) and (*d*) were analysed with the following results, which are shown in comparison with the range of corresponding figures recorded at the Imperial Institute for samples of cassava starch from various sources :

—	British Honduras samples		Cassava starch from various sources
	(*c*)	(*d*)	
	Per cent	*Per cent*	*Per cent*
Moisture . . .	14 2	13 9	13 1–21·7
Crude proteins . .	0 1	0 2	nil– 0 5
Starch (by acid hydrolysis) .	78 2	78 4	73 6–82 8
Crude fibre . . .	0 2	0 3	nil– 0 1
Ash	0 5	0 4	0 06–0·6
Prussic acid	nil	0 0008	—

Both samples from British Honduras were of satisfactory composition, although the amounts of starch present were not quite so high as in the case of commercial cassava starch of good quality, which usually contains from 82 to 83 per cent.

Gelatinisation tests were carried out with the present samples, and showed that sample (*d*) was better than (*c*) as regards colour and was also slightly superior to the latter in respect of consistence. The samples were not of such good colour as commercial samples of cassava starch (tapioca flour) with which they were compared, but were of average quality as regards consistence.

Sample (*e*), as previously mentioned, consisted of a fine meal, and it could not be properly classified as a " starch." Gelatinisation tests showed it to be much inferior to the samples of starch (*c*) and (*d*).

The products, with the exception of the small sample (*e*), were submitted to manufacturers and merchants who furnished the following opinions regarding the commercial possibilities.

(1) The manufacturers, after examining the samples, reported that the cassava chips corresponded very closely in starch percentage with the material they obtain from Java. They commonly purchase cassava roots ground to a fine powder, but not dressed in any way, and they pointed out that such grinding effects a considerable saving in freight. They stated that if the shippers would forward them a consignment of, say, 10 to 20 tons of the ground roots, equal in quality to the average of the present samples (*a*) and (*b*), they would be prepared to purchase it at a price not exceeding £6 10*s*. per ton c.i.f. Bristol, and to give it a trial with a view to the possible development of business. This price was quoted in June 1928, but six months later the firm stated that the price of ground cassava roots from Java had risen to £7 17*s*. 6*d*. per ton, and they were prepared to receive a trial shipment at or about this figure.

(2) The merchants stated that they were prepared to do business in the dried sliced roots, both in the United Kingdom and on the Continent, if supplies could be offered at

prices ranging from £7 to £8 per ton c.i.f. United Kingdom. As regards the starches, the quality was considered satisfactory, but owing to the supplies obtainable from Brazil the firm were not inclined to advise producers in British Honduras to embark on the production of any large quantity at the present time, especially in view of the abundance of cheap starches arriving on the market from various sources and the reduced demand for sizing material in Lancashire on account of the present state of the textile trade. Should, however, any business be possible in the cassava starch, its current value would be about £14 to £14 5*s*. per ton c.i.f. in the United Kingdom (June 1928). The firm also mentioned that there is an outlet for both the roots and the starch in America and that they might be in a position to introduce the products to certain users in that country.

With reference to the foregoing valuations, it will be observed that the manufacturers offered £6 10*s*. per ton for the roots in a ground condition, whilst the merchants were prepared to consider business at £7 to £8 per ton for the sliced roots. It was a matter for consideration whether, provided these prices were maintained, the saving in freight resulting from the grinding of the roots would compensate for the difference between these prices and the cost of grinding.

The small sample (*e*) described as " specially prepared starch " would probably only be suitable for the same purposes as the roots (e.g. in the manufacture of cattle foods) and realise about the same price.

From the foregoing results it will be seen that the sliced or ground roots and also the starch should find a market in the United Kingdom as well as on the Continent and in America, if shipments could be offered at suitable prices. It was therefore suggested that if values such as those assigned to the present samples by the firms consulted appeared likely to enable the materials to be produced commercially at a profit, a trial shipment of the ground roots might be forwarded to the firm of manufacturers, and large representative samples of the sliced roots and starch to the merchants with a view to obtaining orders. Unfortunately the company who had supplied the samples suspended activities indefinitely and nothing further could be done at that time.

Subsequently, however, in September 1930, small parcels of dried roots (sliced) and starch were sent to the firm of merchants referred to above. They reported that the material showed very careful preparation and was almost exactly similar to the products shipped from Brazil to this country. Prices by this time, however, had reached a low level, starch being 11*s.* 6*d.* per cwt. c.i.f. London, with indications of it falling still lower, and the sliced roots would realise under £4 per ton for ordinary commercial consignments. It was thought, however, that it might be possible to find a special outlet for the sliced roots in small quantities, say 10 to 25 ton lots.

It is understood that quite recently the question of making cassava starch in British Honduras has again been taken up and is receiving the serious attention of the local Government.

ZAMIA FURFURACEA STARCH

The sample of starch which is the subject of this report was forwarded to the Imperial Institute by the Agricultural Officer in March 1934. The material was stated to have been prepared from the underground stems of *Zamia furfuracea* L.f., a plant which is indigenous to the Colony and grows without cultivation on the Pine Ridge sandy soils.

The sample consisted of slightly granular starch, of fair colour, but gritty in the mouth. It was analysed with the following results, which are shown in comparison with figures obtained with cassava flour and with a sample of the No. 1 grade of commercial St. Vincent arrowroot :

	Present sample	Cassava Flour (typical analysis)	Commercial St. Vincent arrowroot No 1 Grade.
	Per cent	*Per cent*	*Per cent.*
Moisture	14·6	14·4	15·9
Crude proteins	0·4	0·1	0·1
Fat	0·2	0·15	0·2
Starch (by acid hydrolysis) . .	80·6	82·8	78·7
Other carbohydrates, etc (by difference)	2·6	2·35	4·9
Crude fibre	0·2	nil	0·1
Ash	1·4[1]	0·2	0·1
[1] Including silica	1·0	—	—

A gelatinisation test was carried out by boiling 10 grams of the Zamia starch with 100 cc. of water. The jelly obtained by this treatment was of somewhat firmer consistence than that yielded under the same conditions by the St. Vincent arrowroot, but of slightly inferior colour.

The results of examination show that the sample contains a satisfactorily high percentage of starch, but the amount of protein present is slightly higher than is desirable. The ash content (1·4 per cent.) is moreover abnormally high, as the amount in commercial starches of good quality does not usually exceed 0·2 per cent. Most of the ash consisted of silica and it therefore seems possible that some contamination had occurred during the preparation of the sample.

For the above reasons, and on account of the somewhat unsatisfactory colour of the material, it is unlikely that starch of the quality of the present sample could be remuneratively marketed in the United Kingdom. These defects could be avoided by the exercise of greater care in preparation and more thorough washing, and an improved starch would thus be obtainable which should be marketable in competition with potato starch and cassava starch (tapioca flour). These starches are now selling in London at prices ranging from 10*s.* to 16*s.* per cwt. spot according to quality (May 1934).

It was suggested to the authorities that if it is considered that such prices are likely to be remunerative on a commercial scale it would be advisable to prepare a further sample of a few pounds of the starch and forward it to the Imperial Institute for examination. If found to be of suitable quality, the material could be submitted to trade experts and a definite valuation obtained.

ARTICLES

THE RESOURCES OF BRITISH HONDURAS

ALTHOUGH the first settlement in British Honduras is believed to have been made as far back as 1638, when adventurers from Jamaica were attracted by the logwood growing there, very little agricultural development has taken place in the Colony. In recent years, however, the possibilities of the country have been the subject of serious attention by the authorities. In 1920 Mr. W. R. Dunlop, of the Imperial Department of Agriculture for the West Indies, visited the Colony and issued a "Report on the Economic and Natural Features of British Honduras in relation to Agriculture, with proposals for Development." Since then, Mr. H. C. Sampson, C.I.E, Economic Botanist, Royal Botanic Gardens, Kew, and Mr. F. A. Stockdale, C.M.G., C.B.E., Agricultural Adviser to the Secretary of State for the Colonies, have investigated the agricultural conditions and prospects and issued reports (*Empire Marketing Board Publication No.* 16, 1929, and *Colonial Advisory Council Paper No.* 128, 1932, respectively).

In August 1933, Mr. A. W. Pim was commissioned by the Secretary of State for the Colonies to carry out an enquiry into the economic and financial position of the Colony. Mr. Pim, with Mr. S. E. V. Luke of the Colonial Office as Secretary to the Commission, spent two months in the country, about half of which time was spent in travelling into the interior and through the coastal regions. His Report, under the title "British Honduras: Financial and Economic Position," has just been issued by H.M. Stationery Office (Cmd. 4586, 1934, price 4*s.* 6*d.*).

The Report discusses fully the financial history and present financial position of the Colony; the various Government Departments and Public Bodies; the question of public debt; the possibilities of development of agriculture in the several districts of the Colony, including the banana, sugar, coconut and live-stock industries; the organisation of markets; the sponge fishery; land settlement, forests and land tax; and improvement of communications.

Some of the chief recommendations contained in the Report include, so far as agricultural development is concerned, the establishment of an Agricultural Station at Corozal, in the extreme north of the Colony, with a substation at Orange Walk, about 25 miles inland, financial assistance from the Government for the establishment of a Central Sugar factory in the Corozal District, and assistance in establishing a coconut products factory at Belize. It is also proposed that arrangements should be made with the Government of Jamaica for obtaining scientific advice on agricultural matters and with the Government of Barbados as regards the testing of varieties of sugar-cane.

It is pointed out that an experimental settlement near the Belize River for the relief of unemployment in Belize may be desirable, whilst the possibility of other agricultural settlements will depend on the prospects of suitable settlers from outside the Colony being available and of remunerative permanent crops.

The Colony has, in the sponge fisheries at Turneffe, the basis of a marine industry which appears to hold out good prospects, if developed scientifically and exploited on conservative lines. It is therefore proposed in the Report that a grant should be made to meet the salary of a scientific expert to control the industry for three years.

The improvement of communications is an urgent matter and it is recommended that roads be constructed between Corozal and Orange Walk and, in the extreme south, between Punta Gorda and San Antonio, with a possible extension to San Pedro.

Mr. Pim concludes his report in the following words: " No confident forecast can be made of the economic future of the Colony, as this will so largely depend on the markets for timber including both mahogany, the secondary hardwoods, and pine. The measures proposed, especially those connected with the land tax, should, however, prevent the further depletion of the resources of the Colony in the more valuable woods, and should ultimately result both in a substantial increase in those resources and in such a concentration as would assist their economical exploitation. On the side of agriculture they should, if steadily pursued, be of material assistance in making the Colony less dependent on imports for many essential commodities. Both as regards the forests and as regards agriculture and communications, continuity in policy and persistent work will be essential. Rapid progress cannot be expected, more especially in agriculture, as not only material but also very difficult mental and moral obstacles have to be surmounted."

The Report is accompanied by a map showing the Private and Leased Crown Lands, another showing the geological deposits, and a larger, coloured, map showing the distribution of the various types of forest.

The opening chapters of the Report contain an excellent account of the country and its resources, and a large part of them is reprinted with some modification in the following pages. Some of the products mentioned, and certain others of minor importance, have been the subject of investigation at the Imperial Institute, and in order to make the story more complete, the principal reports on these materials are published in the previous section of this BULLETIN (page 356).

GENERAL DESCRIPTION

Geographical Position

British Honduras lies on the Atlantic coast of Central America between the latitudes of 15° 54′ and 18° 29′ North. It is bounded on the north by the Mexican Province of Quintano Roo, the boundary following for the most part the course of the River Hondo. To the west and south it borders on the Republic of Guatemala. The southern boundary follows the Sarstoon River which separates it from the Guatemalan State of Izabal, but the southern half of the western boundary between the Colony and the Guatemalan State of Peten, though laid down in principle by a Convention in 1859, is only now being demarcated on the ground. Peten is separated from the main portion of Guatemala by the Alta Vera Pas Mountains, and the easiest exit for a large proportion of the produce of its forests is through the colony to the Caribbean Sea. From the northern part of Peten there is an alternative exit through Mexico.

The total area of British Honduras is 8,598 square miles, an area about equal to that of Wales or Palestine. Its greatest length is 174 miles, and breadth 68 miles.

From an economic standpoint its proximity to Jamaica (600 miles), New Orleans (860 miles), Tela in the Republic of Honduras (119 miles), and Puerto Barrios in Guatemala (120 miles) is important. The distance from England is 4,700 miles.

The sea communications are, however, seriously affected by the existence of a barrier reef with a number of islands, locally called Cays, extending almost the entire length of the Colony at a distance of from 15 to 20 miles from the coast. The only important navigable channel through this reef is at English Cay opposite the centre of the Colony, fifteen miles south-east of Belize. South of the reef there is deep water and there is a channel, suited to ocean-going ships of moderate size, between the reef and the coast up as far as Belize. North of that town the depth of water precludes navigation by ships of any size.

The mainland of the Colony may be divided, from the geological point of view, into two main areas lying respectively north and south of a line from El Cayo on the western frontier to the mouth of the Mullins River. North of this line the formations are limestones of different types, marls predominating north of the Belize River and the hard Rio Dolce limestone in the more broken and hilly country south of that river. South of this line the Rio Dolce limestone forms a belt along the western frontier and appears in outlying hills to the south and south-east. An area of 650 square miles to the south-east is occupied by the Toledo shales, and the central mass, rising to a height of about 3,750 ft. in the Cockscomb Mountains and the Great Southern Pine Ridge, is composed of granite and igneous rocks estimated to cover 370 square miles and of slates estimated to cover 1,020 square miles.

A feature common to both divisions of the Colony is a coastal belt, from 5 to 10 miles wide, extending from Corozal in the north to almost the extreme south, and representing an area which has only been raised above the sea during the last few thousand years and which is still but little above sea-level. The mainland is described in Mr. L. H. Ower's report on the Geology of British Honduras as still slowly rising, but the cays as sinking to compensate. As regards Turneffe, however, the latter conclusion appears to be doubtful. The coastal belt is specially marked in the northern half of the Colony, where mangrove and swamp savannah country extends for several miles up from the mouth of the Belize River and also along the New River and the Hondo. The remainder of this coastal belt is for the most part occupied either by extensive lagoons, or by large areas of the so-called pine ridges, which are, in reality, tracts of poor low-lying arenaceous soil forming either dry savannahs with grass of no fodder value or forests of pitch pine, for the most part seriously damaged by forest fires, but including some extensive areas with good stands of pine.

Through this coastal belt flow seventeen principal, and other minor, rivers, having their source in the hills or swamps of the interior, more especially in the Cockscomb Mountains and the Great Southern Pine Ridge. Three flow northwards to Chetumal Bay, near Corozal, and the remainder east or south-east to the Gulf of Honduras. The northern rivers are relatively slow running and deep, corresponding to the gradual increase in height above sea-level to a maximum of 200 to 400 ft. near the western border. The southern rivers—except Deep River, which will take large ships for some distance—are fast running and shallow, owing to the rapid approach to the central mass of mountains. A feature common to all the rivers is the existence of raised banks, or levees, of alluvial soil, of widths varying from a few yards along the northern rivers to strips of several hundred yards along such rivers as Stann Creek and Monkey River. These alluvial strips are as a rule separated from the pine ridges by belts of swamp. The earlier attempts at cultivation have as a rule been in these alluvial strips, but their value is seriously reduced by the liability of the rivers deriving from the central mass of mountains to sudden heavy floods, known locally as " top gallant " floods, when the crops are attacked not only from the rivers but from the swamps behind them. These floods have been very destructive during the last few years.

The only rivers navigable for a considerable distance by boats drawing more water than the native dug-out craft, known as "doreys," or the larger "pitpans," are the Belize River, which is much the most important, and the New River in the north. Navigation on the Belize River is, however, greatly hindered in the dry weather by stretches of shallow rapids, often necessitating the boats being slowly pulled up by hand, and is dangerous in times of heavy floods.

Climate and Rainfall

A Colony with a coast-line of 200 miles and a considerable range of height above sea-level naturally shows substantial differences in climatic conditions. The average temperature on the coast is about 80° F., and ranges between 50° F. and 95° F. Temperatures up to 100° F. occur in the interior in the dry season, but usually the nights are cool.

Rainfall statistics for a number of places are available since 1906. For several reasons the records may not be altogether reliable, but taking them at their face value and eliminating four abnormal years (1906, 1907, 1929 and 1931), they show an average fall for Corozal between 1906 to 1932 of 47·1 in. For Orange Walk the corresponding figure, after omitting the abnormal fall of 1925, is 51·6 in. Farther south the rainfall is heavier; allowing for the breaks in the records, 75 in. appears to be a normal figure at Belize and Stann Creek Town, 100 at the Industrial School in Stann Creek, 140 at Middlesex farther up that valley near the hills, and 150 at Punta Gorda. The period of heavy rains is in general from June to October or November.

On the whole, the climate appears to be healthy for a tropical country and by no means an unpleasant one except during August and September, when the humid atmosphere is trying. Mr. Pim remarks that the climate experienced during his journey over the Great Southern Pine Ridge would have been considered delightful in any country. On the coast, sea breezes blow almost throughout the year except during the night, when there is usually a land breeze from the west. In November and December strong and relatively cold winds from the north, locally called " northers," are common.

After the disaster of 1931 the Colony can no longer claim immunity from hurricanes as it used to do, but they have been very rare occurrences. It is much less subject to droughts than many parts of Jamaica.

During the dry season from January to May very serious damage is sometimes done by forest fires, but for this the system of " milpa " cultivation and the usual method of hunting the scanty game in the forests are largely responsible. The pine forests on the Great Southern Pine Ridge have been largely destroyed in this way, and their disappearance might have very serious effects in increasing the danger of erosion and of the sudden heavy floods in the rivers. The losses caused by these floods to plantations on the river levees have, as already stated, been a marked feature of recent years and may be partly due to the destruction by fire of the forests in their catchment areas.

Health

The most serious dangers from disease arise from malaria, hook-worm, consumption, and, to a certain extent, from dysentery. Both malaria and hook-worm are certainly prevalent, the debilitating effects of the latter being specially marked among the Maya Indians. Both diseases are capable of being greatly reduced, but it would be very difficult to enforce the necessary measures under existing conditions. Yellow fever can hardly be now counted as a serious danger in the light of modern knowledge. The last outbreak occurred in 1921, when it was very rapidly stamped out with the assistance of a staff despatched at once by the Rockefeller Foundation. The possibility of its recurrence cannot, however, be altogether ignored so long as the Stegomyia mosquitoes abound, as they certainly do in some areas. On the other hand, various biting insects make conditions very unpleasant at some seasons, more especially in certain areas. The most trying species tend, however, to diminish as settlement extends.

Population

For a country with an area equal to that of Wales the Colony is very sparsely inhabited, and the character and distribution of such population as exists makes development, and more especially agricultural development, a task of special difficulty. The total population enumerated in the census of 1931 was 51,347 persons, including 25,524 males and 25,823 females. Of these, more than half, or 27,145, lived in urban areas, leaving only 24,202 for the entire rural area. Belize alone had a population of 16,687, but there has been some reduction since the hurricane of 1931. A proportion of the urban residents, more especially in the smaller towns, are doubtless agriculturists, but they would be much exceeded by the number of persons living in rural areas who are engaged in work connected with the forests, including more especially work on mahogany extraction and chicle collection, or in trade and transport of all kinds. Apart from the Indian and Spanish villages in the Corozal and Orange Walk districts and the Maya and Kekchi villages in the San Antonio area of the Toledo district, the rural population is practically confined to the neighbourhood of the rivers. A large proportion of the Colony is absolutely uninhabited, more especially the central mountainous area about which very little is known.

Agricultural Position

The total number of persons classified in the 1931 census under agricultural occupations was 6,051, made up of 5,708 males and 343 females. This head, however, includes foresters, woodmen and coconut planters. Small cultivators, with holdings under 10 acres, number 3,796 males and 324 females. The quality of the cultivation is no more satisfactory than its quantity. As Mr. Sampson wrote in 1928 " agriculture—i.e. the cultivation of the ground—can hardly be said to exist in the Colony." The largest body of cultivators—the Indians—use no implements except the machete, or cutlass, and a pointed stick, while under their wasteful and destructive " milpa " system of cultivation they plant a new area every year, or at most every second year, by burning a new section of forest in the areas reserved for their use. The methods of the Caribs are a little better, as their women, at any rate, use the hoe and cultivate the same area for somewhat longer periods, but, with occasional outstanding exceptions, the agriculture of the Creoles is of the same fugitive type. Even on the sugar plantations ploughs are hardly ever used, and ratooning up to ten, or even twenty, years, with hardly any weeding or other cultivation, is the usual practice. The citrus plantations and the new Government Settlement Scheme in Stann Creek, a few market gardens (mostly under Chinese, East Indian and Creole ownership), the East Indian Settlement near Punta Gorda, and a number of small settlements of Jamaicans are the only prominent exceptions.

Even of the crops produced a large proportion is wasted, as there are no satisfactory methods for drying the produce or protecting it from weevils which, in this moist climate, cause such heavy damage ; the losses from these causes are especially severe in the south, where the rainfall is more than twice that in the north, and lime, which is used by growers in the northern districts for mixing with their grain, is not available. Further, except for citrus, there is as yet no organised marketing system, though one is in contemplation for non-perishable foodstuffs.

The industry of stock-rearing is no more advanced than that of arable cultivation. Cattle have been bred to some extent for the purpose of hauling mahogany, more especially at Banana Bank on the upper reaches of the Belize River, at four other farms in that neighbourhood and at the Toledo Settlement near Punta Gorda. With the introduction of tractors for hauling mahogany logs, the demand for cattle has largely diminished, though they are still employed for hauling logs along the wing-passes to the tractors on the main truck-passes. Until recently the beef requirements of Belize were met by imports from Spanish Honduras, but these have now ceased, mainly as the result of increased duties, and the local demand is met by cattle from the farms near Banana Bank. It is, however, noticeable that the demand is almost entirely for small animals with a dead weight of not more than two or three hundred pounds. Only on Saturdays can a few larger animals be disposed of.

The absence of a dairy industry, except to a very limited extent in Belize itself, is in all probability largely due to the absence of any suitable grazing area within reachable distance of that town, and to the swamps which, until a road was very recently constructed across them, encircled it on the west. Practically the whole of the milk requirements of the Colony are met by large imports of tinned milk, and there is, in fact, no desire for any supply of fresh milk.

Means of Transport

In most areas the waterways are the only practical means of transport, although on nearly all rivers—as already stated—no craft other than "doreys," or at most "pitpans," can find a sufficient depth of water in the dry season. Two short canals supplement the rivers by connecting the Sibun River with the Belize River and with the Northern Lagoon.

Outside the towns the total mileage of improved roads is 20½ miles in the Corozal district (area 718 square miles), 8¾ miles in the Cayo district (area 1,629 square miles) and 10 miles in the Toledo district (area 2,119 square miles). Stann Creek has no improved roads, but has 25 miles of railway; Orange Walk district (area 1,500 square miles) has neither, though a private logging railway extends for some 12 miles from Hillbank, the headquarters of the Belize Estate and Produce Company. The most important recent extension of communications has been the continuation of a road from Belize, intended ultimately to open up communication with El Cayo, but the 38 miles hitherto constructed is almost entirely over uninhabited pine ridge and the real difficulties of construction still remain to be tackled on the remaining 50 miles. Elsewhere, mule transport is the only means of carriage apart from the waterways, and 574 miles of rough bush tracks are kept open as far as possible by a periodical cutting down of the bush with machetes. Many of these are, however, little better than a succession of quagmires, practically impassable in wet weather.

Forests

The Colony has, up to the present, relied almost entirely on its forest resources and has devoted all its energies to their exploitation. With the exception of the small areas cleared for cultivation or residence, the savannahs—wet and dry—and those stretches of pine ridge which are bare of trees, the whole of British Honduras is thickly forested.

In accordance with the nomenclature followed by Mr. J. N. Oliphant in his report for the British Empire Forestry Conference of 1928, the forests may be divided into five main classes :

(1) Mangrove forests.
(2) Savannah forests—wet and dry.
(3) Pine forests.
(4) Primary Rain forests.
(5) Secondary Rain forests.

The first two classes are of no economic importance. As regards the third, very little has been done up to the present in the development or commercial exploitation of the pine forests, which are of the pitch-pine type. Annual fires have in many places reduced these forests to little more than savannah country, but reproduction is good, if fire protection can be provided, and, as the world supplies of this class of timber are rapidly diminishing, there appear to be prospects of a limited profitable use in the future, more especially as the pine areas are for the most part on Crown land.

The remaining two classes provide the valuable woods, and more especially the hardwoods, such as mahogany (*Swietenia macrophylla* King), cedar (*Cedrela mexicana* Roem.), sapodilla (*Achras Sapota* L.), from which chicle, the basis of chewing gum, is obtained by tapping, santa maria, yemeri, rosewood and banak.

Logwood (*Hæmatoxylon campechianum* L.), for more than a century the main economic support of the Colony, is now of no importance, and, apart from sapodilla-tapping for chicle, the only woods which have been exploited on any scale are mahogany and cedar with a small quantity of rosewood, yemeri and banak.

The Primary Rain forests may be considered first. The normal succession from wet savannah is to swamp forest, locally called by the Maya Indian name of " Acacai," which is for the most part confined to the northern plains, where it usually skirts the pine forests. The tree growth is stunted and dense, and, although mahogany trees are numerous and the wood of high quality, the growth is exceedingly slow and the supply of exploitable wood from trees with the standard girth of 7 ft. 6 in. is very limited. The next stage is that of the " Intermediate Forest," constituting the transition stage between pine forest, or swamp forest, and the final stage of " Advanced Rain forest." The local name for the early stages of this type is " Broken Ridge," in which " Ridge " implies belt and has no connection with elevation. This stage has a dense growth, including all the trees of commercial importance, though some are confined to the calcareous soils of the north and others to the area south of the Sibun River ; rosewood is only found in the Toledo beds of the southern district. Local custom in the northern half of the Colony recognises a number of additional sub-divisions based on the presence or absence of special trees, such as the " Give and Take " palm, the " Pokena boy " palm, and the " Kaway " tree. The following description of the types of forest recognised in the northern plain has been drawn up by the local Manager of the Belize Estate and Produce Company.

(1) *Pine Forest Lands.*—These lands carry a fair stocking of *Pinus caribœa,* which is exploitable for consumption in the West Indies. Pimento palm present, also oak and yaha.

(2) *Dry Savannah Lands.*—Useless and valueless from a production point of view. These lands carry a scanty covering of poor grass. Their present state is the result of annual fire-burning over a long period. Pimento palm absent.

(3) *Wet Savannah Lands.*—These are composed of swamps and pans. As a rule they carry a covering of rank coarse grass, with scattered clumps of useless bushes or small trees. Such lands are useless and without value at present. Pimento palm present.

(4) *Acachai.*—Height growth, 20–30 ft. This is the lowest form of broad-leaf bush. It is usually found on pan formation and is the result of inadequate drainage. It

may carry logwood of good quality, otherwise such land has no value at present. It often carries mahogany, which, if present, are plentiful but of small girth. Girth never exceeds 6 ft. at breast height. Owing to the open nature of the ground, cover regeneration can be good, if present.

(5) *Low Broken Ridge.*—Height growth, 30–40 ft. Poor drainage. Carries bay leaf. Mahogany of excellent quality grows in this forest type, but is of poor growth. Trees never exceed 8 ft. at breast height. Exceptions usually possess bad heartwood. This land has little value at the present time. Regeneration of mahogany is good owing to the open nature of the ground cover.

(6) *High Broken Ridge.*—Height growth, 40–50 ft. Drainage fair on surface. Carries bay leaf and sometimes cohune. Mahogany of slow growth and excellent quality grows plentifully on such land, but growth seldom exceeds 9 ft. girth at breast height. On such land, mahogany stems seldom grow straight for more than 24 ft. Natural regeneration is good. Ground cover is fairly open.

(7) *Ordinary High Ridge.*—This is an open type of forest which carries neither bay leaf nor cohune. It carries a fairly good stock of mahogany of good quality. Height growth is good. The mahogany trees are found in spasmodic patches, and where these patches exist the trees are in close proximity. In the vicinity of such areas according to the prevailing wind natural regeneration is good. The ground cover is open.

(8) *Bay Leaf Ridge.*—Good mahogany bush characterised by abundance of bay leaf and presence of Pipe reed grass. Mahogany is of good stocking, quality wood, excellent height growth with timber to 50 ft. and girth dimension up to 2½ fathoms above spurs. Natural regeneration is good. Surface drainage as a rule is good. This type of bush will grow any tropical crop suited to this Colony.

(9) *Mahogany Ridge.*—Excellent mahogany forest characterised by the presence of bay leaf and cohune. The further remarks which have been made above under (8) apply to this type of bush, with girth growth up to 3 fathoms.

(10) *Give-and-Take Ridge.*—Mahogany forest typified by the plentiful undergrowth of Give-and-Take palm. Bay leaf is present and cohune may or may not be present. This forest type carries quality mahogany. Growth is slow. Drainage of surface is fairly good. Height growth gives 40 to 50 ft. of timber and girth dimension goes up to 2 fathoms above spurs. Ground cover is fairly open. Natural regeneration is good.

(11) *Pokena Boy Ridge.*—This is a wet type of forest carrying heavy undergrowth of Pokena Boy palm. It may or may not carry a light stocking of cohune. Drainage is inadequate. Carries mahogany of large size, free, straight grained and light. Natural regeneration is poor.

(12) *Kaway Ridge.*—This is wet forest with bad ground conditions typical of a swamp and characterised by the Kaway tree. The areas are low-lying and surface drainage is bad. Carries cohune. Mahogany is of large growth, free, straight grained and light. In many cases the trees cannot be extracted owing to the bad ground conditions. Natural regeneration is poor.

(13) *Dry Cohune Ridge.*—The forest has a very rich soil. Tree growth generally is large. Undergrowth consists of a dense stocking of cohune tending to become dominant. Drainage is good. Mahogany is of large dimensions with girth up to 4 fathoms, the wood being free grained and straight. Natural regeneration is poor, due to dominating ground cover of cohune. Excellent agricultural land.

(14) *Wet Cohune Ridge.*—This is a wet type of forest, low-lying, possessing inadequate surface drainage. Otherwise, the further remarks made under (13) apply also to this forest type. For agricultural purposes adequate drainage would have to be effected.

The final stage of the Primary Rain forest is the Advanced forest, the climax of tropical growth, though in reality a state of equilibrium as regards the constituent species is never attained. The growth is one of the most luxuriant in the world and is characterised by the prevalence of the Cohune Palm (*Attalea Cohune* Mart.) to a more or less marked degree. This palm is specially characteristic of the so-called " Cohune ridge " occupying the fertile soils of the stream alluvial and granitic basins. Mahogany trees of great size occur in this type of forest, but it has the lowest stock per acre of any profitable type of forest, and natural regeneration is so retarded by the dense shade that the species is gradually disappearing in many areas. The Forest Trust has lately prepared a vegetation map as the result of the exploration work carried on by their officers during the last ten years. It is reproduced as map No. 3 in Mr. Pim's Report and represents a valuable addition to the knowledge of the Colony.

On the marls of the north, on the richer soil of the limestone areas of the centre, south and west, on the granitic basins of the central block, and on a part of the Toledo beds of the south, the primary or virgin forest has given place to secondary forest as a result of the cultivation of these areas during the ancient Maya civilisation, which disappeared so incomprehensibly from this part of Central America during the sixth century A.D. New evidences of their occupation are constantly coming to light and it seems, in fact, doubtful whether true primary forest exists in any area suited to agriculture. Mahogany and its associated species are found in either case.

It must, however, be remembered that, even when a forest is said to have merchantable mahogany, the term usually implies at the present time one tree of adequate girth for every two or three or even larger number of acres. The extraction involves an elaborate process of cruising to find the trees in the dense mass of other vegetation, the cutting of a truck-pass—possibly for a long distance—and of wing-passes to the individual trees. Each tree has then to be felled, cleared of branches, cut up into two or three logs, and transported by cattle and by tractors to the nearest river capable of carrying them. The logs are then, often after a wait of months for a flood sufficient to transport timber, floated down to the sea either individually or in rafts, and, if not exported as logs, cut up into lumber for export. When a tree has been felled it will probably be ten or even twenty years before another tree is ready for felling in the same area.

The history of the mahogany and other forest industries is dealt with later, and here it is only necessary to point out that, as the result of serious overcutting and the wholesale removal of immature trees, seed-bearing trees are now insufficient to maintain the stock without artificial aid. Until very recently the community had for two centuries been accustomed to regard its natural resources as inexhaustible and, as half the total forests of the Colony have been alienated, including all the better and more accessible mahogany areas, the Government was not in a position to take any direct measures towards the conservation of the industry, when it at length came to realise the position as the result of Mr. Hummel's valuable report of 1921 and subsequent reports by the Forest Officers.

No obligation to develop the forests, or to work on lines ensuring adequate regeneration, was attached as a condition to private tenure. The private forests have in general been seriously depleted of their more valuable products, more especially of mahogany and sapodilla gum (chicle). The majority of owners have made no attempt to develop the productivity of their estates. The only important exception is The Belize Estate and Produce Company, who instituted in 1926 an organised scheme of reproduction on their Hillbank estate. The subsequent depression has unfortunately forced them to discontinue the organisation, and that area also suffered severely during the hurricane of 1931. Notwithstanding this, however, the Hillbank block, and the tract west of it on the Guatemalan border, appears to be the only large area holding a substantial stock of merchantable mahogany. There are other localities with smaller stocks, but, taking them into account, an annual output of four million, or at most five million board ft., appears to be the maximum which can be aimed at if conservative logging is to be practised. This is in striking contrast to the twenty-one million board ft. exported in 1927, or even to the fourteen million board ft. exported in 1928 and 1929. It would, however, considerably exceed the three and a quarter million and the 643,000 board ft. exported in 1931 and 1932 respectively.

There are now prospects of an increased demand, but the only way in which a substantial trade can again be developed consistently with the proper conservation of the forests as a permanent asset will be by the building up of markets for the secondary timbers and for pine. This is, in fact, the problem to which special attention is now being devoted by the Forest Trust in consultation with the Forest Products Research Laboratory at Princes Risborough. [A considerable amount of work in this direction has also been carried out by the Imperial Institute (see p. 356).]

ECONOMIC HISTORY

Logwood

The early history of the Colony centres on the trade in logwood, to which it owes its origin and retention.

Logwood first became known to Englishmen through a shipwreck in the year 1638, but the first English trade in it appears to have commenced in 1655, about the time of the capture of Jamaica. The price then paid in England was £100 per ton. The Spaniards had already developed a trade in logwood from Campeche, and their endeavours were at first directed to attempting to maintain that monopoly. A regular settlement of the country was never undertaken by them. The attractions of the profits were, however, too great to permit of the monopoly remaining undisputed, and privateers were fitted out, which, if they found no Spanish prizes, landed and cut logwood for themselves. A treaty concluded with Spain in the year 1667 agreed to the abolition of privateering, but agreements concluded at home were apt to be disregarded beyond the line, and the safe shelter afforded by the cays, and the difficult navigation, attracted buccaneers to these shores. In the year 1670 the Governor of Jamaica, who exercised a somewhat vague control over the settlers, urged formal recognition of the logwood cutters and help for these " new sucking Colonies." He expressed the conviction that, when peace was made with Spain, two-thirds of the remaining privateers would take up the logwood trade and that " those soldierly men would be kept within peaceable bounds and be always ready to serve His Majesty in any new rupture."

The Secretary of State, Sir William Godolphin, adopted the cautious attitude of hoping that if there was no other breach of the treaty the Spaniards might be persuaded to connive at the cutting of logwood. The Spanish Government, however, continued its efforts to suppress the industry, describing it in 1732 as " a notorious and detestable abuse," but, notwithstanding their efforts, including the confiscation of all ships engaged in the trade, it increased rapidly. Belize had become the chief port of export by the year 1705.

In 1717 the export of logwood to England was 3,741 tons, and in 1756 it had risen to 18,000 tons. In 1764, twenty-two vessels of 50 to 500 tons burden were engaged in the trade and 1,500 logwood cutters employed.

The treaty of 1763 was the first occasion on which the Spanish Government at length agreed to permit the cutting of logwood, but it made no mention of mahogany, the trade in which was beginning at that time to displace that in logwood. By 1771 it was stated that mahogany had almost entirely supplanted logwood as the principal article of export. The timber exports of 1783 are stated to have included 7,000 tons of logwood and 70,000 tons of mahogany, 8,000 seamen being engaged in the trade. The figures for mahogany seem very questionable, as they are equivalent to between twenty-five and twenty-eight million board ft., which would be considerably in excess of the maximum modern output of twenty-one million board ft. in 1926–27. Mahogany-cutting was not formally recognised until the treaty of 1786, which also extended the boundary of the settlement to the Sibun River and provided for the evacuation of the Mosquito Coast. The latter provision resulted in the addition to the settlement of 537 free and 1,477 slave settlers.

During the nineteenth century the exports of logwood showed great variations ; they were returned at 698 tons in 1802, 1,268 tons in 1805 and 1,856 tons in 1827. The returns of the latter year also show exports of 19,753 lb. of sarsaparilla, 183,960 lb. of indigo and 63,551 lb. of cochineal, but no memory survives of the production of these articles.

In 1751 logwood was transplanted to Jamaica, where it thrived and is still of importance. Notwithstanding this competition the figures of exports show a large increase towards the close of the century, being 34,539 tons in 1896. The following table showing the exports at intervals since 1896 indicates the speedy ruin which overtook this trade early in the twentieth century from the competition of aniline dyes:

Year	Tons	Year	Tons
1896	34,539	1916	7,165
1900	20,521	1920	1,570
1905	9,572	1925	609
1910	3,669	1930	225
1915	1,975		

In 1932, 103 tons were exported for certain limited purposes, but there appear to be no hopes of any substantial revival.

Mahogany

The export trade in mahogany also had a somewhat chequered career during the nineteenth century, and its variations up to date are shown by the following table:

Year	1 000 sq ft	Year	1,000 sq ft
1802	2,250	1900	7,994
1803	4,500	1905	9,958
1805	6,500	1910	10,176
1820	3,000	1912	16,020
1837	8,500	1915	6,907
[1]1845	10,000	1920	9,773
[1]1846	13,750	1925	12,858
1860	7,500	1927	24,726
1870	2,750	1928	16,362
1874	6,000	1929	16,478
1878	3,125	1930	10,829
1880	2,125	1931	3,240
1895	3,000	1932	644
1896	3,000		

[1] *Period of railway expansion in Europe.*

In addition to the above, which represents mahogany in the form of logs, the timber is now also exported as lumber, the figures of which in recent years have been as follows:

Year	Sq ft	Year	Sq ft
1923	38,821	1929	286,318
1925	145,192	1931	144,259
1927	326,513	1932	226,486

It will be seen that after the boom of 1845–46 there was a heavy slump as the result of a glutted market due partly to the introduction of iron for wood in the building of ships. The depression continued until prices were again stimulated by a reversion to the use of mahogany in furniture. There has always been a tendency to overdo production when the markets showed signs of improvement, the temporary booms being followed by the inevitable slump. The annual returns from 1896 onwards show several repetitions of this process, particularly in the period 1925–30, which saw the greatest output of mahogany of which there is authentic record. The introduction of the caterpillar tractor, the boom conditions in the United States of America, and a series of dry seasons combined to create this record. The revival of the glutted markets would in any case have been slow, but has been further retarded by the general depression of trade, more especially in the United States of America, by the local effects of the hurricane of 1931 and by the unfavourable rates of exchange with Great Britain. Other important factors in delaying recovery have been the competition from Peruvian and Brazilian mahogany, and, in the lower grades, from West African mahogany, the popular preference for oak in furniture, provided in immense quantities and in all necessary shapes and sizes by American lumber companies, and, perhaps most important of all, the use of steel in place of wood, both for furniture and for railway carriages and ships. Notwithstanding these handicaps there are now prospects of a very considerable recovery by the year 1934–35, and the Diesel tractor will further extend the possible radius of economical production.

The old practices of excessive production should not, however, be allowed to recur, in view of the present condition of the forests as the result of past overcutting. This has been described already (p. 391), and it is clear that, unless it is intended to allow the rapid destruction of the mahogany trade, the reckless felling of immature trees must no longer be allowed and exports must be limited to from four to five million board ft. This necessary restriction does not, however, imply the discontinuance of the logging industry as an important factor in the welfare of the Colony, because it is still true, as noted by Hooper in 1887, that " the mahogany trade of the past 200 years has not materially affected the forests beyond causing the partial or complete disappearance of one particular species over certain areas." This statement is still true, and there are great forest resources left in the secondary species which have, with the exception of the cedar—the close associate of mahogany—and to some extent of yemeri and banak, remained almost unexplored up to the present. As already stated (p. 392), the future of this major industry in the Colony lies very largely in the exploitation of the secondary hardwoods and of pine.

One essential condition to the adequate preparation of timber for the markets has recently been fulfilled by the erection of a modern saw-mill in Belize by the Belize Estate and Produce Company, with the aid of a loan from Government. The capacity of the mill is considerably in excess of the anticipated production of mahogany by the Company for a considerable time to come, and this additional capacity will, it is understood, be available both for mahogany other than that extracted by the Company, and, if necessary, for secondary hardwoods. As regards mahogany, the mill should make it possible for a considerable proportion of the lumber trade in British Honduras mahogany, hitherto carried on through American agencies, to be retained in British control, while it will also permit of the retention in the Colony of the overrun, representing more than 30 per cent. of the total cut, which has hitherto been absorbed in the United States. Its existence, as a possible alternative to dealing with American firms, will greatly strengthen the position of all local timber agencies in securing profitable terms and in selecting the best markets.

Apart from Cuban mahogany, which occupies a unique position in a market for special uses, the mahogany of British Honduras is recognised as of the highest quality, able to comply with the severest tests, as for example in the construction of aeroplane propellers. A complication is, however, introduced by the fact that the wood produced in the northern half of the Colony shares with the product of northern Guatemala and of Yucatan a definite superiority in quality over that produced in the southern half of the Colony and in the more Southern States of Central

America. As the result of slower growth it is closer in grain than timber from the south, which approximates more to cedar in its characteristics. For the more exacting uses the demand tends to be for the northern wood. On the other hand, its close grain increases its weight and brings much of it to the margin of flotation, so adding to the difficulties of bringing it to the market. Its slower growth implies a longer period before maturity is reached.

Other Timbers

A study of the Trade Returns during the past decade shows that of the secondary timbers, cedar and rosewood have been exported in small quantities each year, but the shipments of other timbers have been irregular and mostly confined to the period 1924–28, when the mahogany boom was at its height. The figures are as follows:

—	Cedar		Rosewood
	Logs	Lumber	
	Sq ft	*Sq ft*	*Tons*
1923	663,437	2,490	62
1924	641,517	—	130½
1925	645,979	100	248
1926	292,741	—	76
1927	733,088	—	137
1928	578,368	—	435
1929	703,520	—	249
1930	383,198	3,096	62
1931	226,865	—	6
1932	1,476	10,200	—

—	Banak	Santa Maria	Tamarind	Yemeri	Pine		
					Logs	Lumber Dressed	Lumber Rough
	Sq ft	*Sq ft*	*Sq ft*	*Sq ft*	*Sq ft*	*Sq ft*	*Sq ft*
1924 .	63,219	21,758	—	1,307	—	—	—
1925 .	377,920	111,716	2,119	40,274	—	30,621	137,049
1926 .	355,256	159,103	—	4,383	—	258,180	164,138
1927 .	10,454	540	—	10,082	—	—	—
1928 .	—	—	—	—	—	4,499	35,806
1930 .	178	—	—	—	—	—	—
1932 .	100,948	—	—	—	11,232	—	—

There were no exports of any of these woods in 1923, 1929 *and* 1931.

Chicle

The remaining forest industry of major importance is that of chicle collection for the manufacture of chewing gum. Chicle is the latex of the Sapodilla tree (*Achras Sapota* L.) and is collected by tapping the trees. This is carried out by wandering chicle collectors, including both Maya and Waika Indians, with a proportion of Negroes and Creoles. The traditional methods involve tapping at intervals of from three to five years, with yields averaging about 5 lb. per tree per operation. Unregulated tapping results in the death of the tree. An inferior product known as Crown Gum is collected in the southern half of the Colony from other Sapotaceous species, probably chiefly *Achras Chicle*. This material has recently been examined at the Imperial Institute (see p. 361).

The trade in chicle commenced in the last decade of the nineteenth century and the variations in exports from 1896 onwards are indicated in the following table :

Year.	Lb.	Year.	Lb.
1896	925,199	1917	2,266,621
1898	255,263	1920	3,690,641
1901	136,391	1922	2,132,252
1904	773,323	1925	3,022,196
1905	1,523,663	1930	4,094,415
1910	2,790,890	1931	2,186,564
1915	3,467,696	1932	1,029,473

These figures include not only chicle produced in the Colony, but also that originating from Guatemala and other outside sources, and exported through the Colony.

The average export—domestic and foreign—of the period 1896 to 1904 was 390,000 lb. Thereafter the export increased steadily from about one and a half million lb. in 1905 to about three million lb. in 1913. All exports during this period were sent to the United States of America. Canada, however, has of recent years been a growing direct, instead of indirect buyer. The local control is the monopoly of one firm.[1] The chief supplies are from Yucatan in Mexico, Peten in Guatemala, and British Honduras. Domestic production has varied from 300,000 lb. to 600,000 lb., but it has recently fallen heavily, partly as the result of exhaustion of supplies by ruthless tapping, which is killing out the sapodilla stock, and partly on account of the economic depression in the United States of America and of the distribution of the amount contracted for over the various collecting areas. The domestic export is only a fraction of the total export (averaging about 15 per cent. during the past decade), and the re-exports have been seriously affected by the raising of the export duty, which has resulted in the diversion of the Peten exports to Mexico. The duty has recently been reduced to its previous figure. There is said to have been recently an experiment in exporting the Peten produce by air to Puerto Barrios.

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[1] At the request of the Conservator of Forests the Imperial Institute recently made enquiries as to the possibility of users in the United Kingdom buying their supplies of chicle direct from British Honduras. As a result tenders have already been called for by one large manufacturer. Arrangements were also made for the insertion of a note in the appropriate trade journal calling attention to the supplies available.

Many attempts have been made to produce a synthetic equivalent, but hitherto without success. On the other hand, the increasing use of other materials in chewing gum, such as jelutong from Malaya, has tended to reduce the demand, and an admixture of a gum found in Colombia has been found essential to the production of some types of chewing gum.

There are, at the present time, large accumulated stocks in the United States of America, so that the trade is likely to be restricted for several years, but an annual production of from 300,000 to 500,000 lb. seems possible for some years to come.

On the other hand, the effective control of such a mobile operation as chicle-collecting is practically impossible, and the better trees are being steadily reduced in number, more especially as the local monopoly of the trade has forced down the price paid to the tapper to an uneconomic level, practically forcing him to tap every tree he can find. The chicle industry cannot, therefore, be regarded as a permanent substantial asset of the Colony.

Cattle Industry

The cattle industry in the Colony has always been primarily for the purposes of producing oxen for timber haulage, and neither beef production nor dairying has been taken into account. The present position of the industry has already been discussed (p. 384). The chief modern developments have been the introduction of cattle dips by Messrs. Melhado & Sons, followed by Mr. Stuart and the Belize Estate and Produce Company, the introduction of the Zebu strain from 1898 onwards and the taking over of the supply of beef to the Belize market. The latter aim resulted in the introduction of Holstein bulls, of which there are a considerable number in Guatemala ; they could not, however, stand up to the Zebu bulls, and imports of these animals have been discontinued in favour of Aberdeen Angus. There are now some 3,500 head of cattle on the upper reaches of the Belize River, belonging to Messrs. Melhado and to a number of small owners, apart from the 1,200 to 1,500 head belonging to the Belize Estate and Produce Company. This state of affairs has probably existed for a considerable period under varying owners. Breeding in the Toledo district has fallen off greatly. There has been no attempt at dairying, but a few cows are kept in Belize and stall-fed on imported fodder.

Agriculture

Agriculture has hitherto held a very minor place in the modern economy of the Colony, though in travelling through the country one comes across many signs of past enterprises, which have failed for one reason or another. Such were cacao at Dolores on the Sarstoon River and at Kendal on the Sittee River, coffee near El Cayo, and sisal and tobacco in the Corozal district. The sugar estates in the Toledo, Orange Walk and Corozal districts almost come in the same category of failure. These attempts were, in the main, sponsored by outside capital with little or no local assistance. Their failure was due *inter alia* to excessive overhead expenses and high cost of production, lack of transportation facilities, and lack of scientific assistance and control.

For a long period after the foundation of the Colony the available labour was almost entirely slave labour imported for work in the forests. The present agricultural elements of the community are comparatively late arrivals. The free and slave settlers from the Mosquito Coast arrived in 1787 and the Caribs of Stann Creek and farther south came in from Ruatan and elsewhere during the first half of the nineteenth century and after the Clayton-Bulwer

Treaty of 1851. The Spanish Yucatecans who first developed a sugar industry and coconut walks in Corozal took refuge in that district about 1847, as the result of the war of races in Mexico, and many of the Indians in that area came over the border during other disturbed periods in that country. The Maya and Kekchi Indians of the San Antonio area in the Toledo district came in from Peten about 1898. Conditions were therefore very unfavourable for agricultural developments even if all plantations had not been, in fact, definitely prohibited by the treaties with Spain up to the year 1798. That influence ceased after the battle of St. George's Cay.

A sugar estate on Manatee River was advertised for sale in 1847, and a Mr. Carmichael, formerly a Liverpool merchant, became a sugar planter on a considerable scale in Corozal. Twelve estates were started subsequently, but all collapsed from careless management and lack of practical experience. Their places have been taken by Spanish owners, who still carry on the production of sugar and rum on very primitive lines. After the American Civil War, fourteen Americans from Louisiana founded the Toledo Settlement near Punta Gorda and engaged in the planting of sugar. They did fairly well until recently, but nearly all the original families have now left, and the remaining estates have for the most part passed into other hands. As in all parts of the West Indies the spread of beet sugar cultivation towards the end of the nineteenth century brought ruin to most of the sugar producers. Both in Corozal and in the Toledo district a small quantity of sugar and rum is still manufactured, but the sugar is almost all unrefined and the methods of growing cane are primitive in the extreme. In the Toledo settlement there is one small vacuum-pan in a most dilapidated condition.

An additional factor in the situation, which would have been of great importance if the Government had attempted to inaugurate a comprehensive policy of agricultural development—which in reality they never contemplated—was the fact that, as already stated, nearly the whole of the better and more accessible areas of the Colony had been alienated to private owners.

Apart from bananas, coconut products and grapefruit, which are dealt with separately below, the only agricultural products recorded as being exported from the Colony are rum, oranges and cocoa beans. The exports of rum rose from 6,066 gallons in 1926 to 14,841 gallons in 1929, and kept at about that figure until 1932 when 13,748 gallons were exported.

Shipments of oranges have only been occasional during the past decade, the only exports recorded being as follows:

Year	Number of Oranges	Year	Number of Oranges
1926 . . .	450	1929 . . .	57[1]
1928 . . .	5,771	1932 . . .	36,200

[1] *Cases.*

As regards cocoa beans, 5,891 lb. were exported in 1928 and 602 lb. in 1930.

On the other hand, relatively considerable quantities of meat and dairy produce, grain, sugar, tobacco, coffee, tea and vegetables have to be imported.

Bananas.—From 1896 to 1912 there was an average annual export of bananas amounting to about 500,000 bunches. They were grown in a large number of small plantations scattered along the numerous river valleys, but more especially in the Stann Creek, Monkey River and Sittee River valleys. The maximum export was reached in 1917 when 887,481 bunches were shipped; since then there has been a steady fall, the exports in 1932 being only 78,867 bunches.

Bananas were first exported about 1880, when 9,000 bunches were shipped to America, and in 1883 Sir D. Morris (*British Honduras: Its Resources and Prospects*) wrote that "there were some thousands of acres of splendid land suitable for banana cultivation which offer every inducement to experienced planters to settle down and reap the returns which must inevitably attend the judicious and careful culture of this fruit."

The prospects of the industry were so promising that the Stann Creek Railway was built in 1911: at about the same time the United Fruit Company purchased the Middlesex Estate of 12,500 acres in that valley and commenced to develop cultivation on a large scale. For a time all went well, but Panama disease first appeared in

1913 and had spread disastrously by 1918. Dunlop's careful study of the position in 1920 led him to the conclusion that the then position might have been prevented, or considerably delayed, if a proper quarantine had been originally established, and if the bananas had been grown on the system of intensive culture rather than on the crude extensive system typical of Central America. This view is supported by Sampson's report of 1928, which says that " it is evident now that the crop was dependent on the surface fertility of the soil, due to accumulations of forest debris on the land, and that when this was depleted the plants succumbed to Panama disease, this disease being particularly virulent on account of the soil acidity and the impervious nature of the subsoil. Not only in the Stann Creek valley, but up the Sittee and Monkey rivers, there were extensive areas of bananas grown along the riverine lands, and even now the cultivation is being extended farther and farther up the river as the plantations lower down succumb to the disease." The report of Wardlaw, of the Imperial College of Tropical Agriculture, on his visit to Stann Creek in 1929, lays special stress on the want of uniformity in the soil, and on the absence of large areas of good banana land.

Mr. Pim mentions that wherever he went, whether in Corozal, in El Cayo, in Stann Creek, in the Toledo district, and even in Belize, the constantly reiterated request was for improved facilities for the export of bananas, with assurances—except in Stann Creek, where this was hardly possible—that, whatever happened in other areas, that particular area was, at any rate, free from the disease.

In Stann Creek itself there are new plantations of bananas right along the valley, most of them, at any rate, cultivated on the lines stigmatised in the Dunlop report. Even on the new Government Settlement in the valley each of the settlers is starting operations by growing bananas, though well aware of the fact that in hardly any cases will the plants survive for more than two years. In several cases the disease is appearing in the first crop owing to the planting of diseased stools. The reason for this apparent disregard of the results of experience is simply that there is no crop which can be compared with the banana for a speedy and substantial return.

So far as could be ascertained, the disease has not hitherto appeared in the Toledo district except towards the mouths of the Sarstoon and Temash rivers. Clear evidence was afforded by the large area newly planted by the East Indians in the Toledo Settlement that new facilities for export, even of the uncertain kind afforded by one small steamer and occasional schooners, will lead to a speedy response in an increased supply, and possibly to new settlers from Jamaica or the adjacent Republics. The special insistence on additional facilities for export is due to the fact that the steamers of the United Fruit Company no longer call regularly as they used to do, while the depressed state of the market also tends to restrict their operations in minor centres of supply. Unless a satisfactory banana immune from the Panama disease can be developed, and marketing arrangements satisfactorily concluded, it would appear most inadvisable for Government to inaugurate at present in the southern half of the Colony any settlement scheme which depended for its success on the Gros Michel banana.

For the present, at any rate, bananas cannot be counted on for any large developments, although, if grown with suitable precautions, they may give valuable assistance in tiding over the interval necessary for the establishment of some more permanent crop. Plantains can continue but can never form an export of much commercial importance.

Coconuts and Copra.—The growing of coconuts has also an important place in the Colony's economic life. They

Year.	Coconuts. No.	Copra. Lb.
1896	1,707,041	—
1900	2,407,130	—
1905	4,929,700	—
1911	5,198,899	14,448
1914	9,315,040	—
1915	8,268,530	159,800
1920	6,263,069	58,011
1923	5,964,706	1,897,623
1925	5,783,158	676,318
1927	5,929,834	2,002,870
1930	4,760,135	1,653,296
1932	2,974,220	995,704

are grown in many parts of the country adjacent to the sea, or to more or less brackish inland waters. The most important coconut walks are in the Corozal and San Pedro areas, including Ambergris Cay, and the preceding figures show what an important adjunct coconuts and copra have been to the Colony's exports.

It will be seen that the exports of coconuts have greatly fallen off, but even now there is a fair seasonal demand for select nuts, chiefly for shipment to Canada and the United States of America for use in confectionery and for canning. The price of the nuts has varied greatly. For the years 1911 to 1917 it averaged about $22 per thousand, but it had been as low as $9 per thousand. In 1919 it went as high as $54 with an average of $45. In 1920 it was $26, but fell rapidly. In 1932 the average price was $8·50 and in 1933 about $8·75 per thousand.

The position is a good deal more unfavourable for copra, in which the export trade was negligible before 1922. Exports are now confined to a small quantity sent to Mexico for use in soap factories. The present New York c.i.f. price of 1⅛ cents per lb. is so unremunerative that most of the coconut walks are no longer cleared of undergrowth and are in a very dilapidated condition. The price is mainly determined by the London market, where the competition is very severe with whale oil and with certain other vegetable oils. In any case, the methods of copra preparation are thoroughly bad, as sun-drying is totally unsuited to the country, and the only kiln in existence is of an inferior type and is, in fact, not used. The loss as the result of faulty methods of preparation is less from the slightly lower prices obtainable for bad copra than from the actual loss of a considerable proportion of the crop, estimated at about 15 per cent.

A scheme has been put forward for establishing a coconut products factory at Belize, as has already been done in Trinidad and Jamaica.

Grapefruit.—The only really successful recent development is the grapefruit industry of the Stann Creek Valley. That industry owes its origin to what was practically a hobby on the part of a few pioneers, notably Messrs. Bowman, Brown and Vine. They were fortunate in starting with an excellent strain of a budded grapefruit—Marsh's Seedless—obtained from Florida. They commenced operations about 1913, but the excellence of their produce was not realised for a considerable period, and it was not until the year 1925–26 that regular exports commenced with 3,756 cases. The figures since that date for the seasonal years August 1 to July 31 are shown below:

Year	Cases	Year	Cases.
1926–27	3,363	1930–31	1,796
1927–28	3,364	1931–32	2,966
1928–29	2,341	1932–33	2,214
1929–30	3,927		

Mr. Vine's plantation was taken over by the Industrial School at Pomona and other groves were planted, while production was gradually developed on scientific lines, including more especially the substitution of budded plants on sour orange stocks for seedlings. Mr. Bowman won the gold medal at the Imperial Fruit Show for the highest quality of grapefruit two years in succession. The Industrial School also won both the gold and silver medals on one occasion.

The total area under grapefruit is now 500 acres, but of this only about 148 acres are bearing, and only a small proportion is in full bearing. Exports in the year 1933–34 are estimated at 13,000 cases and the estimate for 1936–37 is put at 50,000 cases, rising to a maximum of 100,000 cases about 1940. A cleaning, grading and packing plant is now in process of erection, and the whole industry is being carried on on co-operative lines, with adequate precautions for the maintenance of the high quality of the exports. Besides the plantations at Stann Creek, two other plantations, with an area of 75 acres, have been planted in the Corozal district. Full control has not been assumed in that area under the Ordinance controlling the industry, but its products will have to be brought under some form of control in the interests of the industry as a whole.

The Turneffe Sponge Industry

The sponge industry is of old standing, as the conditions are eminently favourable to the growth of sponges. Turneffe consists of a large number of low coral islands, for the most part clothed with mangroves and other swamp vegetation, but with a considerable area under coconuts, a large proportion of which were destroyed by the hurricane in 1931. The islands are separated from one another by a labyrinth of creeks and surround two large shallow lagoons with a total area of some one hundred square miles. Communication with the open sea is afforded by a small number of channels through the enclosing barrier reef. Two conditions most essential to the growth of sponges—a supply of decaying vegetable matter and a tidal circulation—are therefore fulfilled, though the latter is liable to be interfered with by changes in the banks, and the deposits in some parts of the lagoon are muddy, or otherwise unsuited to sponges. On the whole, however, it may be described as a natural nursery suited to the production of sponges of a type similar to those produced in the large fisheries in the Bahamas and of a comparable quality, a slight inferiority in the " wool " sponges being compensated by a slight superiority in the " velvet " type.

The fisheries are, as stated above, of old standing, but, as in the case of mahogany in the forests, they were destroyed by reckless exploitation, the sponges being much less able to resist its effects than the tree. Only in 1926 was the matter taken up seriously, by which time the stock of sponges had entirely, or almost entirely, disappeared over the greater part of the lagoons. A scientific expert of established reputation, Mr. L. R. Crawshay, was appointed in that year and, except for an interval in 1929, has since been engaged on the problem of reviving the fisheries, in which all operations were closed. An assistant was appointed in 1931, the salaries of both officers being met by grants from the Colonial Research Fund. These grants ceased at the end of March 1934, but, as already mentioned (p. 377), Mr. Pim recommends that a grant be made to meet the salary of a scientific expert to control the industry for a further period of three years.

In view of the position of almost total depletion an immense amount of preliminary work was required in investigating the suitability of the various parts of the sea for different types of sponges, in selecting the sponges suitable for reproduction by cutting into sections, and in increasing the supply of material available for the sponge concessions necessary for the commercial revival of the industry. Not only are there wide variations in the sponges of a particular type, but the sponges of one brood have their individual characteristics and the individuals will vary in development according to the environment in which they are placed. A severe set-back was suffered from the hurricane of 1931 which destroyed a large proportion of the accumulated stocks, though this has been compensated in some of the worst affected areas by an improvement in the character of the bottom by the removal of muddy deposits, so improving the prospects for the future. Other set-backs occurred from the discovery that some of the areas selected for depots were unsuitable, as being subject to heavy mortality among the sponges. Notwithstanding these difficulties, and the many other puzzling problems which presented themselves, a fine piece of scientific work has been carried out in the selection of areas suitable as reserves or for the purpose of concessions, in the accumulation of what may be termed pedigree sponges of the more valuable varieties, more especially of " wool " and " velvet " sponges, and in the accumulation and careful record of a mass of valuable information.

Four concessions have actually been given out, one of which has reached the productive stage, though the holder of the concession is wisely confining himself for the present to increasing his own stock and to supplying another concession. Four other concessions are under consideration, but their giving out is delayed by the necessity of careful tests of the suitability of each area being carried out for a year or even two years, and the recognition that a concession should be stocked with some 1,500 sponges instead of the 500 originally contemplated. As sponges can be reproduced by section cutting for a period of, probably, thirty to forty years, and each section attains a size allowing of cutting into further sections in about three years, a general rate of reproduction of doubling in geometrical progression can be anticipated. Some " pedigree " sponges have already yielded up to 2,000 sections. Therefore, although progress in the direction of a money return has not been as rapid as was anticipated, and some concession holders have objected to the restrictions on the fishing of native sponges, the general position is satisfactory, and it rests on a sound scientific basis.

It may be mentioned that one, at least, of the concession holders is considering the possibility of bleaching the sponges before export instead of shipping them in the crude state as is the usual practice with West Indian sponges. At his request experiments have been conducted at the Imperial Institute in order to ascertain the method of bleaching most likely to meet his requirements, and a report on the subject has been furnished.

The Cohune Nut Industry

The operations of the Tropical Oil Products Company in the Toledo district commenced in the year 1929. Their purpose was the formation of plantations of the cohune palm and the development of an oil industry from cohune nuts, with the aid of a nut-cracking machine which is stated to have been tried out on a commercial scale in Spanish Honduras. Cohune oil is commonly used by the Indians of Yucatan and Honduras for household purposes, but their methods of extraction are naturally crude and not adapted to the development of an industry.

When work commenced in February 1929, the Company controlled 46,000 acres of a private estate, including approximately 22,000 acres of cohune ridge suited to the growth of this palm. During 1929 and 1930, 16,000 acres were cleared of other trees and of undergrowth at a cost of $5·00 per acre. The undergrowth had again to be cleared three times in the first year, at a cost of $2·00 per acre on the first occasion and $1·00 for the two subsequent clearings. For the maintenance of plantation conditions three clearings annually would continue to be essential, but the cost would be gradually reduced. Experiments were then carried out in the direction of increasing the number of trees from the six per acre which represents the average under forest conditions to the maximum number possible under plantation conditions. The optimum spacing is considered to be about 26 ft. Other experiments were directed to selecting the best trees and to improving the conditions so as to increase the proportion of female flowers and the average number of bunches per tree. The trees are estimated to reach full productivity in about fifteen years, but the first six to eight years are occupied by the growth downwards from the seed, which at first only reaches a depth of about six inches. Some $700,000 were spent on the preliminary operations, which gave employment to a large number of men, the maximum strength being about 1,000. Before crushing operations could be commenced the economic depression set in, and its growing severity has so restricted the available capital that all clearing operations were suspended except in about fifty acres, kept free of undergrowth for experimental purposes. The commercial prospects of the industry are therefore still uncertain, though a superiority in some respects is claimed for cohune oil over that produced from copra, more especially for edible purposes and for cosmetics. The by-products are also stated to be of possible commercial importance. [Cohune nut oil was examined at the Imperial Institute many years ago (see this BULLETIN, 1903, **1**, 25), whilst a more detailed report on the nuts, including the fat found in the fibrous layer of the fruit, the kernel oil and the residual oil cake, was published later (1914, **12**, 237).]

It is clear that production can be greatly increased under plantation conditions, and that these would be essential to the development of an industry, but the formation of a plantation would necessarily involve the removal of all timber trees. If a market for the secondary woods comes into existence, it is questionable whether the cohune nut industry would represent the most profitable use of these forests, more especially as an abandoned plantation would be useless for any forest purpose for many years and possibly permanently. This question is of importance in connection with possible negotiations for the extension of the operations of the Company on Crown land.

CACAO FERMENTATION IN WEST AFRICA[1]

BY A. W. KNAPP

THE success of the cacao industry on the West Coast of Africa has been phenomenal. On the Gold Coast and in Nigeria the plantations are owned and worked by the natives, and this is the most striking example known of rapid development in a native-owned industry. Although its introduction is relatively recent, these two British possessions produce more than one-half of the world's cacao.

The quality was poor at first as the natives had no knowledge of proper preparation for the market. It has much improved, but still leaves something to be desired. The manufacturers prefer fermented cacao because it produces cocoa and chocolate with a finer aroma and a richer flavour. As the quantity produced in West Africa is so great, the methods of fermentation and drying used there are of considerable importance to the world's cocoa and chocolate manufacturers.

On the Ivory Coast, in the Cameroons and San Thomé, there are important European-controlled plantations as well as the native producers' holdings.

In 1932 the production of cacao on the Gold Coast amounted to 231,791 metric tons, Nigeria 68,837, Ivory Coast 25,777 and Cameroons 17,126. The total world production was 567,052 metric tons.

It was reported in 1933 that the Gold Coast cacao seeds (popularly called beans) were getting smaller and lower in cacao butter content. My figures from the year 1916 to 1932 give no support for this, however. It is true that the beans for the season 1932–33 were smaller than any since 1916–17, the " good fermented " weighing on the average 1·05 grams against an average for the previous 16 years of 1·10 grams, and this fact may have given rise to the report.

Up to about 1900 the great bulk of the cacao exported from the Gold Coast was simply dried in the sun. From then a steady increase in the amount of fermented cacao occurred, but in pre-war days even the best was liable at times to contain as much as 8 to 10 per cent. of unfermented beans.

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[1] Reprinted from the *Journal of the Society of Chemical Industry*, May 18, 1934, Vol. LIII, No. 20, pp. 151 T–158 T, by kind permission of the author and of the Editor of the journal.

The Government have for some years examined samples of every shipment. In these samples the average percentages of perfect beans exported during the five seasons 1927–8 to 1932–3 have been found to be 88·8, 89·0, 88·5, 89·8, 89·7, 90·1, showing a slight improvement. This is gratifying, but although the total of all imperfect beans is decreasing, the percentage of unfermented beans in the whole output still hovers about 5 per cent., and there is no evidence of any general improvement in fermentation during the last five years. The fall in prices is the most probable explanation.

—		1932.								1933			
		May	June	July	Aug	Sept	Oct	Nov	Dec	Jan	Feb	Mar	Apr
Unfermented	*per cent*	7·5	7·1	7·3	7·3	5·6	5·2	4·3	4·3	4·7	5·3	4·8	5·8
Total defective	,,	15·8	17·0	16·7	16·1	14·6	10·4	7·3	7·9	9·7	12·5	14·1	15·8

The variation in the quality of the shippings during the season is striking.

Fortunately the great bulk is shipped in November, December and January, when the cacao is at its best. This is in the dry season when cacao can be more easily dried and when the ripe pods are in sufficient abundance to produce large fermentation lots.

The average figures quoted above may give a wrong impression and the obvious ought perhaps to be mentioned, i.e. that thousands of tons of excellently prepared cacao are produced every year—for example, the 4,000 tons of cacao produced by the Co-operative Farmers' Societies in 1932–3 averaged 97·7 per cent. of perfect beans.

The Cacao grown.—The cacao grown in West Africa is of the *Forastero* type, and almost entirely of the *Amelonado* variety. All the beans have, as they come from the pod, a purple interior. (This is so even in those rare cases where the trees on experimental plots, etc., are considered to be *Criollo.*) The pods on the Gold Coast are remarkably uniform in shape, size and colour (green when unripe and yellow when ripe); this also applies to the great bulk of the cacao in Nigeria, although red pods are seen on a few trees round Agege.

Collecting the Pods and Extracting the Beans.—The main crop is harvested between September and February. The number of pickings is few, usually two, but in some places there is only one, and in others there are three. For example, in the Saltpond area on the Gold Coast it is customary to make (1) an early picking to pay labourers' wages, (2) a large picking, the sale of which often provides money for Christmas festivity, and (3) a small picking at the end of the season. Under these conditions it is obvious that all the pods collected cannot be in the ideal condition for harvesting. The effect of the presence of unripe and over-ripe beans will be considered later.

The pods are not always broken immediately they are collected. In some experiments I carried out in 1917 for the late Mr. Tudhope, it was found that leaving the pod for a week before breaking actually slightly improved the flavour of the cacao. In normal practice, however, there is a danger on standing of the development of pod diseases and of the germination of the beans. Hence the interval between collecting and breaking should not exceed three or four days.

The pods are collected in a heap and the mass of seeds is extracted. The seeds are covered with a juicy pulp which has to be got rid of, and as fermented cacao is more easily sold than unfermented, the native generally attempts some simple form of fermentation.

Native Methods of Fermentation

For scientific fermentation it would be necessary to control (1) the temperature, (2) the distribution of moisture, (3) the aeration and (4) the organisms obtaining access. It would also be necessary to give sufficient mixing to ensure evenness.

In considering the methods used on the Gold Coast and in Nigeria, it must be appreciated that all the plantations are native-owned, managed and worked by natives. They naturally adopt the simplest methods although they are influenced in their methods by the price obtained for the cacao they produce, and, to a smaller extent, by the advice and example of the Department of Agriculture. On the Gold Coast and in Nigeria there are at least six different arrangements used for conducting the fermentation: (*a*) the heap, (*b*) the hole, and (*c*) the use of four types of container: the plantain stem frame, the wooden box, the basket and raised bamboo frames. The methods used by natives on the Ivory Coast are very similar.

The Heap.—This is the most generally used method. Plantain leaves are placed on a clean, level, well-drained piece of ground in the plantation, the heap of beans is placed on this, forming a conical mound, and the whole covered with several layers of plantain leaves. These are sometimes held in place by stems or pieces of wood. The heap is left thus for any convenient number of days—the accepted correct period is 6 days, but the movement of the price of cacao beans often determines how long the cacao is allowed to remain. The heap is generally supposed to be turned once every two days, but this is very often neglected; the loss of quality due to lack of turning is either not appreciated or ignored by the farmers.

The size of the heap varies greatly, a diameter of 6 ft. and a height of 2 ft. being satisfactory dimensions, but generally they are smaller, and often only 2 to 4 ft. in diameter.

The Hole or Pit.—Occasionally on the Gold Coast and frequently in Nigeria, the cacao farmer uses small basin-shaped holes, about 2 ft. deep and 3 to 4 ft. in diameter, lined with plantain leaves. Fermenting in holes is definitely slower and inferior to the use of heaps, partly because the juice (sweatings) cannot run away and partly because of the lack of effective aeration. The method has obvious objections during rainy weather and should be discouraged. The hole was the most usual method on the Gold Coast in pre-war days. The Agricultural Officers' advice that the heap was preferable met with a wide acceptance because the heap gave better results with less labour.

At least four types of containers are used to a limited extent on the Gold Coast and in Nigeria.

(1) *Wooden Boxes.*—The type in use at the Botanic Gardens at Aburi and at Cadbury Hall, Kumasi, consists of three boxes built of stout wood arranged in steps. The width is about 3 ft., the length possibly 6 ft. This three-tier box system has been imitated by some of the advanced natives, but usually the native has only one box and this is often a small one, e.g. a gin box. The use of boxes is exceptional and their distribution irregular ; thus a box is never seen in the Central Provinces around Saltpond, yet right up in the Sunyani area a few of the more important planters have box fermentaries. The intention is to turn the beans from one box to another every second day.

(2) *Baskets.*—In some places in the Kumasi area baskets are used. The one the author tested at Kumasi was circular, 2 ft. 3 in. in diameter, 1 ft. 7 in. high, and held about 274 lb. of wet cacao. The baskets may be made of slender raffia stems and are completely lined with fresh plantain leaves before use. The cacao is supposed to have one thorough mixing on the third day.

(3) *Frames of Plantain Stems.*—In some districts of the Gold Coast and on the Ivory Coast this device is the one most frequently used. It is a frame without top or bottom. Four stout plantain stems about 3 ft. 6 in. long are placed in a square and walls of plantain stems about 1 ft. 6 in. high are built up on the four sides. The inside is lined with plantain leaves and sometimes a light roof is built over to keep out the rain. In this way is obtained a compact mass of beans, in depth about 1 to 2 ft. The beans are generally stirred once on the third day, usually by treading.

(4) *Large Raised Bamboo Frames.*—In the Agege area in Nigeria the author saw large frames raised 1 or 2 ft. from the ground made with a loose scaffolding of bamboo, etc. The cacao was placed on split bamboo mats and covered with banana leaves or bamboo mats. The frames had a floor area up to 10 ft. by 10 ft., some heaps yielding over a ton of dry cacao. The beans were mixed on the third day. The temperatures of the mass in the centre were generally high, but with small heaps the edges were cold and in one of these cases a little mould was present.

EXPERIMENTAL

Comparison of Fermenting Cacao in Different Containers

By the courtesy of Mr. H. Nicholas at Cadbury Hall, Kumasi, and with the assistance of the native students, the author was able to carry out comparative tests with three of the above types of container.

(*a*) *Wooden Boxes.*—In this experiment three boxes were used, arranged as steps. 639 lb. of wet Cundeamor cacao were put in the top box; this, after two days, was turned into the second box and, after two further days, into the third box, and then taken out to dry on the sixth day.

The purple substance in the pigment cells (see Fig. 1) was not distributed throughout the cotyledons until after 3 days. On removing the beans after 6 days, the pulp was a good reddish-brown, and there was no difference in the appearance of the pulp of the beans on the surface of the box and those below. They were very plump and juicy and, in many cases, taking a section, the cotyledons were oxidised to brown to a depth of about $\frac{1}{16}$ in. No mould was apparent in any part of the box, nor were any germinated beans noted. The temperatures of the centre are recorded in Fig. 2. Samples were taken from the box each day, dried, and examined. The colour of a section of the cotyledons was, after 2 days' fermentation, mainly slate-grey; after 3 days, heliotrope; after 5 days, brownish-purple. The finished product after 6 days had the general appearance of satisfactory fermented Gold Coast cacao.

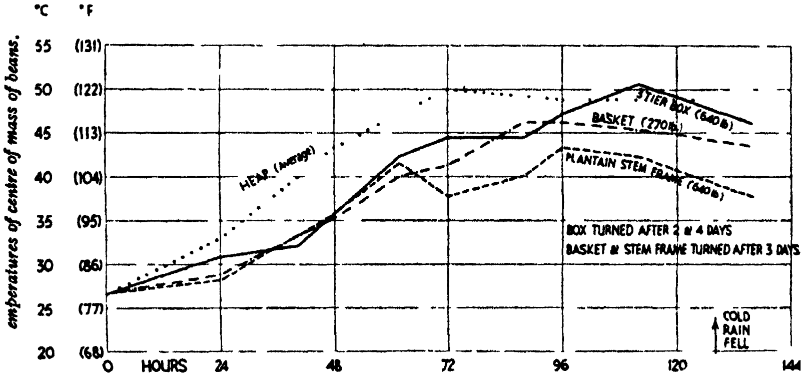

FIG. 2.—Comparison of box, basket and stem frame put on at the same time.

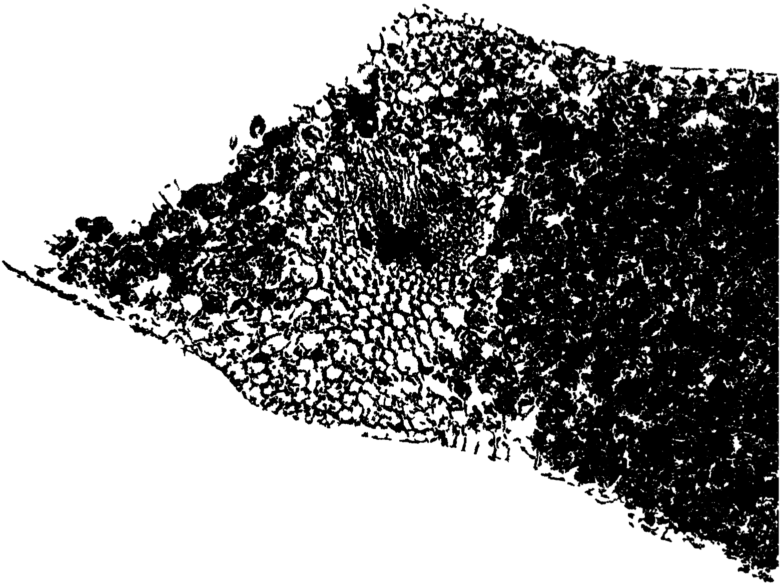

Fig. 1. Section through dry unfermented Gold Coast cacao seed. The isolated black patches are cells containing a purple substance. During fermentation this is dispersed more or less evenly through the cotyledons. Average size of purple masses 0.003 in.

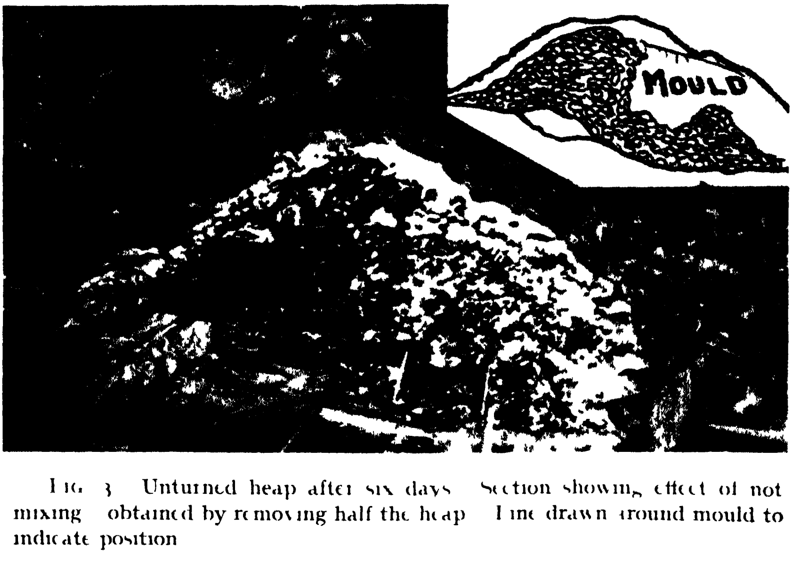

Fig. 3. Unturned heap after six days. Section showing effect of not mixing obtained by removing half the heap. Line drawn around mould to indicate position.

Whilst not specially well fermented, it contained no mouldy, germinated or other defective beans.

An experiment in the same boxes with the more usual Amelonado cacao, whilst different in certain other respects, gave all the changes recorded above.

(*b*) *Basket Fermentation.*—Into the basket, as described above, were placed 274 lb. of wet cacao (Cundeamor). The sweatings began to drain out immediately, and after one day a frothy liquid ran away from the bottom. The colour, etc., of the beans changed much in the same way as with those in the wooden box, and by the fourth day the beans were plump and full of juice. By the sixth day the purple spot (due to exudation of the juice round the cotyledons through the testa) often seen on the outside of beans was very evident and generally occurred at the broad shoulder of the bean. The cacao was given only one mixing, and that was on the third day. The samples taken from the basket each day and dried showed similar characteristics to those from the box.

(*c*) *Frame of Plantain Stems.*—637 lb. of Ocumare cacao were used and gave a depth of about 1 ft. 3 in. The frame was in the plantation under the trees, where on several days the atmosphere felt like that of a Turkish bath ; the shade temperature was actually one or two degrees higher than outside, and the air was still and humid, the relative humidity in the mornings being about 90 per cent. Both the boxes and the basket were in a more exposed position. Although the beans were well mixed on the third day, the temperature of the mass on the fourth was uneven. On the sixth day the beans were not so brown externally as those in the box or basket. At the bottom of the frame the beans were cold and pale and incompletely fermented. There was a little mould growth at two of the corners. Samples taken from the frame each day and dried showed similar characteristics to those from the box and basket. There were no mouldy or germinated beans.

Although fermentation proceeded somewhat more satisfactorily in the three-tier box than in either of the other containers, after a careful examination of all the beans—both before and after roasting—the author decided that there was little to choose between the box, basket or plantain stem frame as containers for the conducting of fermentation. Care, and adequate mixing, are essential in all cases to obtain a good product.

Fermenting Unripe and Over-ripe Cacao

In both these experiments the wet cacao was placed, in a muslin bag, about two-thirds the way up from the bottom of the box of normal cacao, the fermentation of which is described under "(*a*) wooden boxes." The temperature conditions were thus those of a normal fermentation.

The pods which were taken for the unripe cacao were silvery-green in colour, and the pulp inside was opaque and hard. Some of the beans were put to dry after 4 days' and 6 days' fermentation. In both cases the pulp had an unpleasant odour and was gummy or ropy, rather than mucilaginous or pasty, whilst the beans appeared spongy or rubbery. On drying, the beans were small and flat, shrivelled and shrunk. The shell was very hard. The cotyledons were rather hard. The colour of some was fairly good, some were *café-au-lait* colour, but mainly they were woody and the cutting was opalescent. On roasting, the beans had a nasty sour odour and flavour, with very little that was characteristic of cacao.

The over-ripe cacao beans when taken out of the pods had so little pulp on them, and what pulp they had was so transparent, that they were red-brown in colour. After 6 days' fermentation they had a very good appearance—somewhat browner outside, somewhat paler inside, than normal. On drying these were slightly preferable to ordinary Accra cacao ; that is to say they were lighter and richer in colour than the ordinary mixed sample. The shell in some cases was objectionably frail and brittle.

The bad effect of unripe cacao having been noted, a hundred pods harvested by a careful picker were examined. They showed the following colours : golden-yellow, with brownish-orange patches, 26 ; yellow all over, 30 ; yellow and greenish-yellow, with green near stalk, 27 ; greenish, with half of pod next to stalk green, 17. None of these pods was immature, and none of them was definitely unripe. In all cases the beans were loose in the pods and the pulp was soft and juicy. It was concluded that the beans from all these pods would ferment satisfactorily, but that those from the yellow and golden-yellow pods would be preferable. In Ibadan, T. Laycock showed the author two lots of beans fermented under similar conditions in heaps and pits, one from an ordinary farmer's picking and one from carefully picked ripe pods. The farmer's pickings gave less well-fermented products in both tests.

Quantities used by Natives

Whilst quite large quantities are used for fermentation in a few cases, the smaller farmer's holding of a few acres does not allow of this. Many of the heaps and the boxes and baskets are too small to give a satisfactory fermentation, any mass below 100 lb. having so much surface in relation to volume that too much cooling occurs. The author saw a few heaps on the ground 6 ft. in diameter, a few 4 ft. and quite a number 3 ft. or less. The same dimensions for the heaps apply to the raised bamboo frames in Nigeria. Few large baskets and boxes were seen, but small shallow baskets only 2 ft. in diameter, and boxes only 2 ft. long, are used on the Gold Coast and in Nigeria.

Temperatures Obtained

The first point that impressed the author was the high temperatures which were so rapidly obtained and so easily maintained in native heaps 4 ft. or more in diameter. On the second day a temperature of 110° F. (43° C.) was not uncommon both on the Gold Coast and in Nigeria. On the other hand, the three-tier boxes (e.g. at Cadbury Hall, Kumasi) gave lower temperatures (lower in the later stages than is obtained in the ordinary sets of boxes on the ground in Trinidad); this is largely due to the mixing after 2 and 4 days, but is assisted by the two upper boxes being suspended in the air and not surrounded by the walls of the building. Hence they suffer considerable cooling.

The conditions both for growth and fermentation of cacao on the Gold Coast are favourable. Save in the driest areas the climate appears ideal for its growth, and the atmospheric conditions and the micro-organisms present result in the native heap being at least half a day ahead, in the early stages of fermentation as practised in most other countries. Whereas in Trinidad it is usual to reach the stage at which the pigment is diffused through the bean in about 60 hours after starting, it is not infrequently reached in heaps on the Gold Coast in 48 hours. This is an advantage because until the seed is killed the useful internal changes cannot occur. The heap, however, provides imperfect aeration, and hence the later conditions are not entirely satisfactory.

Those who are familiar with sugar fermentations in temperate climates will be struck by the high temperatures obtained in fermenting the sugary pulp of the cacao bean. In the native heap temperatures of 50° C. and over are quite usual. Whilst yeasts are certainly responsible for temperatures of 40° C. and over, whether they are mainly responsible for these very high temperatures I do not know. They certainly survive them, being in evidence throughout the fermentation.

Ciferri[1] gives three important yeasts in cacao fermentation which have an optimum temperature of 40° C.: *Saccharomyces ellipsoideus* var. *tropicus* (a wine yeast with round cells, adapted to tropical countries),[2] *Schizosaccharomyces Bussei*, and *Torulopsis Lillienfeld-Toalii*. Two other yeasts generally found are *Sacch. anomalus* (now *Endomyces anomalus*) and *Sacch. theobromæ* (Preyer), now re-christened *Eutorulopsis theobromæ*, which has an optimum temperature for growth of 35° C.

Yeasts with high optimum temperatures are of interest and may be of importance to any who handle sugars and sugar syrups, just as thermophilic bacteria are of interest to canners: both may cause trouble in the factory. The bacteria normally found on fermenting cacao are acetic and lactic acid bacteria. In temperate climates acetic acid bacteria (*B. Pasteurianus*, *B. aceti* and *Mycoderma vini*) and the lactic-acid bacterium (*B. lactis acidi*) are regarded as being impaired at a temperature of 42° C. Yet the high temperature obtained in fermentation boxes in Trinidad, where no mould is observed, would seem to point to the presence of thermophilic and thermogenetic bacteria. Bacteria do not seem to be so much in evidence in Gold Coast fermentations as in the West Indies, and the cacao produced is not as pungent with acetic acid as is Trinidad cacao.

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[1] *J. Dept Agric*, Porto Rico, 1931

[2] A Otto has shown that the wine yeast is not able to break up the pulp of the coffee berry, and considers that this may apply also to cacao.

On the Gold Coast, R. H. Bunting has shown that undisturbed fermenting heaps of cacao frequently contain *Aspergillus fumigatus*, which generates heat and is capable of raising a fermenting mass to 54° C. It is often accompanied by *Mucor* nov. sp. 463, which is a thermophile. These are the two commonest moulds in unturned native heaps, and it must be concluded that the high temperatures observed are partly due to the development of these moulds.

Considerable variations in temperature occur between the centre and sides of the mass of fermenting beans. Individual figures naturally show considerable variation, but boxes and baskets are very similar, the sides being only about 2° C. lower than the centre. In the stem box, unless carefully packed, air currents may set up which result in very irregular cooling and heating. The most serious case of variation of heating occurs in heaps, as these have a relatively large surface ; the upper part of the heap averages 5° C. (9° F.) lower than the centre, and the bottom edges of the heap are frequently 10° C. (18° F.) lower than the centre.

The Unturned Heap

It will be clear from the above temperatures that, for even fermentation, mixing or turning is essential. As turning or mixing is more honoured in the breach than the observance, the presence of these permanent cool places has a serious detrimental effect on the quality. The bottom may never reach the lethal conditions for the seed, and hence germination may occur or fermentation may not take place. The author saw one small heap which had been left undisturbed for 10 days ; it contained 33 per cent. of germinated beans. What frequently happens is illustrated by the examination of cacao beans taken by the author from various parts of a normal heap near Aburi, Gold Coast. The heap was 4 ft. in diameter and about 2 ft. high. It was well covered top and bottom with plantain leaves, and the beans from any diseased pods had been carefully separated. As frequently happens, the heap was left undisturbed. After 3 days the heap had a faint odour of acetic acid, and the pulp on the beans was beginning to brown and showed budding yeasts and non-motile bacteria. The seeds were for the most part killed and the pigment diffused through the cotyledons, which were externally brown.

It is desirable in fermentation that the seed should be killed before the processes of germination have materially advanced.

Fig. 3 shows the appearance of a section through the heap after six days' fermentation, and the table below gives the characters of the cacao from the various parts of the heap.

DIFFERENCES IN BEANS FROM CENTRE, SIDE AND BOTTOM OF HEAP

—	Temp (° C) after		Condition of Beans after 6 days
	3 days	6 days	
Centre .	49°	49 5°	Beans fresh from heap appeared well fermented, juicy within, and slightly browned These beans on drying had the properties of well-fermented Accra cacao
Side .	44°	42°	(*a*) *Non-mouldy Area* —These beans on drying had 4 per cent germinated and were under-fermented No mould noted (*b*) *Mouldy Area* —These beans on drying had 2 per cent germinated and were slightly under-fermented Shells mouldy externally No mould inside visible to eye.
Bottom .	37°	32°	These beans were taken from the outer edge at the bottom Some had a white bloom of yeast on them About 1 in 5 were germinated, the germs projecting ¼ in. in some cases These beans on drying had in many cases brighter or cleaner shells. They showed 23 per cent germinated, 50 per cent unfermented and most of the remainder under-fermented.

The presence of masses of mould growth within the heap has been investigated by R. H. Bunting and H. A. Dade.[1] It is important and will be commented on later.

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[1] *Gold Coast Year Book*, 1928, pp. 44, 77.

The heap above is definitely a bad case, but it illustrates well a general failing of Gold Coast cacao. At one time when the author examined a bag of Gold Coast cacao and noted that it contained with the fermented cacao some germinated, unfermented and under-fermented beans, he concluded that it was a mixture of cacao from several farmers. It is now evident that from one and the same heap all these varieties will be produced and that whilst the variable character of Gold Coast cacao is due in some cases to mixing of different small lots, in many others it is simply due to the uneven fermentation which occurs in heaps which have not been turned.

The following data, which were supplied to the author by H. A. Dade, are interesting as illustrating his point that a single mixing is sufficient to hamper mould growth in the heap which normally does not appear until the fifth day. Native heap A was 4 ft. in diameter and 2 ft. 5 in. high. The placentas were not separated in the first instance, but were removed after three days' fermentation and the heap was re-formed. Native heap B was 2 ft. 5 in. in diameter and 1 ft. high. In this case placentas were removed before making the heap, and the heap was left undisturbed.

TEMPERATURES, ° C.

	Heap A			Heap B		
	Centre	Side	Bottom	Centre	Side	Bottom
After 1 day .	30°	29°	28°	—	—	—
,, 2 days .	42°	39°	34°	43·5°	40°	33°
,, 3 ,, .	50°	46°	52°	49°	44°	37°
,, 4 ,, .	52°	47°	44°	50°	46°	40°
,, 5 ,, .	54°	49°	45°	53°	47°	42·5°
	One mixing—no moulding			No mixing—mouldy		

On examining the dried beans from these heaps, the author found those from the centre of both heaps slightly under-fermented but otherwise satisfactory. The samples from the bottom showed 9 per cent. unfermented in A, and 13 per cent. unfermented in B, and a considerable quantity of under-fermented in both cases. It is evident that although one mixing prevents mould growth it is insufficient to ensure an even and satisfactory fermentation.

Turning and Mixing

Whilst the author considers daily turning is the ideal, provided it be done in such a way as to avoid too great a reduction of temperature, he has examined the cacao produced by T. Laycock in Nigeria in which he varied the periods of turning, and in these tests no advantage was found in daily turning as compared with every other day. The author considers that the one single change which would produce the greatest improvement in Gold Coast cacao is the universal adoption of turning—suitable times being after 48 hours' and 96 hours' fermentation. This would ensure more even fermentation, better aeration, and freedom from germination and mould.

Mould Growth during Fermentation

To those who, like the author, are familiar with fermentations in the West Indies, the very frequent production of mould on the Gold Coast causes surprise. Although it is possible to get mould in box fermentation, the author has found its occurrence abnormal. This is mainly because turning or stirring is universally used by those who have boxes. Even in that very inferior West African method in which pits are used, little or no mould growth is observed if the beans are turned from one pit to another every one, two or three days.

If a section is made of an unturned native heap after 6 days, the central portion is generally free from obvious mould growth. All around the outside for a depth of from 4 to 7 in. is a white growth of matted mycelium.[1] On the surface luxuriant sporulation produces grey patches. There is only a little mould along the bottom, the carbon dioxide presumably inhibiting free growth. In the section of the heap (Fig. 3) the line shows how deeply the mould has penetrated in one place, the temperature of the nearest side being 42° C.

The objections to mould growth during fermentation are two. Firstly, the cacao is in undisturbed contact with mould and may acquire an objectionable flavour or absorb abnormal substances. Actually there is little or no evidence that this occurs. Secondly, the skin of the seed may be weakened and the way opened for attack by mould during fermentation or drying. H. A. Dade[1] has done some valuable research on this. He realised the possibility of a ring of weakened tissue existing in the testa opposite to the tip of the radicle. He showed that mould penetrates this weak place and spreads up and around the radicle. He appears to have established this only for beans on the outside of the heap, i.e. in areas of lower temperature where incipient germination is likely to occur. It may perhaps be well to state that pod disease fungi do not cause the mould found in the commercial product. The two fungi found in quantity in native fermenting heaps are the sea-green *Aspergillus fumigatus* and the olive-grey *Mucor* (*Cymomucor*) nov. sp. 463. These penetrate the testa and provide a means of entrance for the moulds which can grow under less moist conditions and which develop during protracted drying. These include the bright greenish-yellow or brown *Aspergillus flavus*, the yellow-brown *A. tamari* and the brown-black *A. niger*, which are perhaps the three most frequently found in mouldy commercial cacao.[2]

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[1] *Gold Coast Year Book*, 1928.

Fermented Beans more Susceptible to Mould

In the examination of commercial cacao one notes that in most samples containing mouldy beans there is an appreciable percentage of unfermented or under-fermented beans. Hence it was thought that unfermented beans were the more likely to develop mould (whereas the presence of both mouldy and unfermented beans was perhaps simply an indication of careless preparation). As the result of the work of R. H. Bunting on the Gold Coast and T. Laycock in Nigeria, it is accepted in West Africa that the reverse is true, and that fermented beans more readily become mouldy. Nevertheless Ciferri, speaking of Samaná and Sanchez cacao, still affirms that the unfermented are the more susceptible.

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[1] *Gold Coast Year Book*, 1928

[2] Schwarz, *Cocoa in West Africa*, 1928 R H Bunting, *Gold Coast Year Book*, 1928. Ciferri, *loc cit.*

Colour of Cuttings or "Break"

Both the scientist and the broker judge the degree of fermentation of the cacao by the appearance of the cuttings. With regard to the internal colour of dry West African beans: (1) Any period over 3 days' fermentation will prevent the beans having a slate-coloured section. (2) Three or four days' fermentation will result in a heliotrope or purple section. (3) No amount of fermentation will give the West African bean a pale brown section. (4) The normal pickings in West Africa are sure to give a percentage of purple-brown beans. Under commercial conditions it is not reasonable to expect 100 per cent. with a dark brown section. (5) The best way to secure a dark brown section is to collect only fully mature beans. These will give an excellent product with 6 days' fermentation and two turnings.

Other Methods than Fermentation

It would appear possible to produce the major changes which are obtained by fermentation if one could kill the seed without destroying the enzymes. By killing the seed the cell walls are allowed to become permeable and the oxidases and other enzymes to come in contact with the tannins, etc. Methods founded on this idea have been suggested, notably by Fickendey[1] and F. L. Stevens.[2] The author has tried these methods, and whilst the desirable colour changes are produced, when the beans are roasted they lack the full chocolate odour and flavour of fermented cacao. Further, the methods are not sufficiently easy of application. With this point in mind, the author has devised the following process. A vessel is half filled with cacao beans straight from the pod, an equal weight of boiling water is added, and the whole mixed vigorously for a few minutes; after 24 hours the water is run off as far as possible and the beans are dried in the sun as usual. The beans so treated have the appearance of fermented cacao. There are, however, two objections to this process. (1) Whilst the product is very even and free from acidity, and is the best the author has seen from any alternative process to fermentation, it has a flatter and less strong chocolate flavour than the normal bean; (2) although simple, the present West African methods involve far less trouble, so that unless the product could be sold at a higher price the process is not likely to be adopted.

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[1] *Bull. Imp Inst.*, 1912, **10**, 243.

[2] Pan-American Scientific Congress, 1924.

So far no alternative process, which has been tested on a large scale, gives so good a product as a carefully conducted fermentation.

Drying the Cacao after Fermentation

The farmer generally leaves the beans fermenting for six days, which is under normal conditions the best period for West African cacao. He ignores the indications of correct fermentation which temperature would supply. The Department of Agriculture in San Thomé consider that the proper fermentation may be regarded as finished when the temperature has fallen from 47° to 35° C. Mr. T. Hunter, who has had a wide experience of native fermentation on the Gold Coast, states that in those exceptional cases where the temperature of the mass drops appreciably on the fourth or fifth day, it is wise to commence drying the beans at once, or an unpleasant decomposition sets in.

The ordinary methods of drying consist in exposing the cacao to the sun. The beans are spread in thin layers on mats on the ground or on mats suspended on trestles. Six days in good drying weather are generally sufficient, but the humidity of the air is such that drying may take two or even three weeks. With good drying the beans should not feel rubbery. Much of the cacao is satisfactorily dried, but when the price is falling the farmer is tempted to scamp fermentation and bring undried, or imperfectly dried, cacao to market. This is a bad practice not completely rectified by the sun-drying on concrete floors carried out by the buyers. In Togoland several farmers have been found drying cacao over open fires, which results in smoky or "hammy" cacao.

The partial oxidation of the tannins, which occurs during fermentation, continues during sun-drying. According to Steinmann[1] the sunlight actually liberates the cacao red, which in the presence of the oxidase is oxidised to cacao brown. The maximum solar temperature on the Gold Coast averages 63° C., which is not far from the optimum temperature for cacao oxidase; it very rarely exceeds 70° C., a temperature above which the oxidase would be destroyed.

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[1] *Z. Unters. Lebensm.*, 1933, 65, 454.

It is common belief that fermentation, or at any rate colour changes, readily take place in the bean after it is dry or nearly dry. Having kept dry unfermented cacao (moisture about 6 per cent.) without apparent change for one or two years in England, the author found this difficult to believe. To test the point, in November 1931, some beans in Accra which were in need of a slight further drying were examined. They had a rather high percentage of the purple close-grained type of cacao associated with under-fermentation (2 per cent. of unfermented and 22 per cent. with a purple section). They were given one hour in the sun and six months' storage. The percentage of unfermented was unchanged, but only 2 per cent. had a pure purple section, the rest having become tinged with brown and were the normal colour for fermented Accra cacao. It would appear that, provided the cacao contains at least 8 per cent. of water, changes of this kind occur, particularly in the tropics. Cacao with 6 per cent. of moisture changes very slowly in England, but after 10 years, if exposed to light, unfermented cacao will be found to have become tinged with brown.

Some of the conclusions the author has drawn from his observations and experiments are as follows:

(1) The farmers and the Government are to be congratulated on the advances made both in quantity and quality of cacao.

(2) Although good cacao can be obtained by the use of baskets and stem frames, the best kind of container is the wooden box.

(3) While prices remain at their present level it is unlikely there will be any considerable extension of the three-tier box system. The system is a good one but, as set up, often has insufficient protection against cooling.

(4) A considerable improvement in quality could be

achieved at once if the cacao in heaps and containers was well and rapidly mixed every two days.

(5) Apart from this vital matter of mixing, the trouble with many of the fermentations is that the separate lots of cacao are too small.

(6) The product would be improved if pickings were more frequently and more carefully taken.

(7) The only way to get large heaps with frequent pickings is for a number of small farmers to ferment their cacao together. This implies mutual trust and an agreed relation between weight of fresh and fermented cacao. Nigeria has a number of communal fermentaries, and if they have not already done so, the Co-operative Societies on the Gold Coast should be encouraged to try them.

The author wishes to express his appreciation of the facilities afforded by the Departments of Agriculture for the Gold Coast and Nigeria during his stay in Africa and to thank Messrs. Cadbury Bros. for permission to publish this paper.

NOTES

Imperial Institute : Appointment of Director.—The following communiqué was issued by the Department of Overseas Trade on September 28 last and is reprinted for general information :

" In pursuance of the powers conferred upon him by the Imperial Institute Act, 1925, Lieut.-Col. John Colville, M.P., J.P., Secretary of the Department of Overseas Trade, has been pleased to appoint Sir Harry Alexander Fanshawe Lindsay, K.C.I.E., C.B.E., I.C.S., to succeed Lieut.-Gen. Sir William Furse, K.C.B., D.S.O., who is retiring from the post of Director of the Imperial Institute, South Kensington, on September 30, 1934.

Sir Harry Lindsay has held important posts in India, including those of Director-General of Commercial Intelligence, Calcutta, 1916–21, and Secretary to the Government of India, Commerce Department, 1922. He left India to take up his appointment as Government of India Trade Commissioner in London in 1923, and in that capacity attended, as adviser for India, the Imperial Economic Conference of 1923, the Imperial Conferences of 1926 and 1930, and the Imperial Economic Conference (Ottawa) of 1932. He was also a member of the Empire Marketing Board.

As Secretary to the Indian Delegation, he took part in the negotiations leading to the United Kingdom-India agreement signed at Ottawa.

Sir Harry Lindsay will take up his new appointment on October 1, 1934.

The Santonin Content of Scottish Artemisia.—In a report on an investigation at the Imperial Institute of the amount of santonin present in Artemisia plants from the coasts of England and Wales, which appeared in this BULLETIN (1934, **32**, 33), reference was made to work on similar lines being carried out by Dr. James Coutts. An abstract of a paper on the seasonal variation of santonin in Scottish Artemisias, which Dr. Coutts read before the British Pharmaceutical Conference, 1934, has now appeared in *The Chemist and Druggist* (1934, **121**, 91). In a previous paper (*Pharm. Journ.*, 1929, **123**, 603) Dr. Coutts showed that a sample of plant material, consisting of a mixture of *A. maritima* Linn. and *A. gallica* Willd., collected on the East Coast of Scotland, contained 0·81 per cent. of santonin. The present investigation was undertaken to determine the maximum percentage of santonin produced by the Scottish artemisias, to observe the seasonal variation in relation to the stage of growth, and to ascertain the proportion present in the different parts of the plant.

The collection of the material at successive stages of growth was commenced in May 1930 and was continued until 1932. Root, stem, leaf and flower-head of the plant were separated wherever possible, but santonin was not found to be present at any time in the root or woody stem. Only the results of the examination of material collected in 1932 are given. In this year eleven collections were made at intervals from June 23 to September 20. The results show that the maximum percentage of santonin is to be found in the leaves immediately before the flower-heads become conspicuous. The highest amount of santonin found was 1·6 per cent. in the leaves at the end of July. A secondary maximum, not so great as the first, occurred just before the flower-heads commenced to expand. With the expansion of the flower-heads the decrease was rapid, and in a few days the santonin had practically disappeared.

Experiments conducted with plants cultivated at Corstorphine showed that the plants continued to produce santonin in the third year of cultivation, although the yield was not so high as that from the wild plant at, as nearly as possible, the same stage of development.

Disposal of Habitation Wastes by the Indore Process. Readers of Howard and Wad's *The Waste Products of Agriculture: Their Utilisation as Humus*, a publication reviewed in this BULLETIN (1932, **30**, 253), are acquainted with the Indore process for the manufacture of fertilising compost from agricultural wastes.

Further work carried out at the Institute of Plant Industry, Indore, Central India, forms the subject of *Bulletin No.* 1, 1934, of that Institute, entitled "The Sanitary Disposal and Agricultural Utilisation of Habitation Waste by the Indore Process," by F. K. Jackson and Y. D. Wad. It marks an important step forward, namely the adaptation of the process to the treatment and useful employment of human excreta.

For centuries in China night soil has been regularly used as an agricultural fertiliser, but the methods employed have not generally been such as would accord with modern ideas of sanitation. On the other hand, in most countries there has been an aversion from regarding human excreta otherwise than as material to be disposed of as unobtrusively as possible, the means employed being considered simply as a sanitation problem. The process that has now been worked out at Indore fulfils all the requirements of good sanitation and, at the same time, through the benefit that it affords to agriculture, converts a financial loss into a substantial profit.

The Bulletin begins with a review of the present position with regard to sanitation and the disposal of night soil and refuse in India, both in rural and urban areas, the insanitary consequences of the methods adopted and the loss that these cause to agriculture ; it emphasises that the ideal means of disposing of habitation wastes is to return them to the land as manure. It is admitted that this has been done in most disposal systems, but the usual methods involve an enormous waste of organic matter and nitrogen, and the value of the material returned to the land seldom even meets the cost of disposal. Reference is made to modern biological systems of disposal, but all of these, from the septic tank to aerobic filters, are concerned mainly with the sanitary aspect of the question, the agricultural side being treated as of minor importance. Some attempts have been made to solve the problem to the best advantage of agriculture, and in 1931 Howard and Wad, in the publication mentioned above, indicated the possible adaptation of the Indore method to habitation wastes.

Trials to that end were begun in 1932 at the disposal grounds of the Indore Municipality and in the Residency area. They were entirely successful from the first, a simple technique was rapidly developed, and the new process was soon in full operation.

For details of the process as operated at Indore, reference must be made to the original publication. Its main features, as therein summarised, are:

"(1) The immediate treatment of both the refuse and night soil, one after the other, as soon as they arrive at the disposal grounds, the carts being backed to the edge of a trench 2 ft. deep and 15 ft. broad.

"(2) The addition of half-rotted compost in small amounts as a starter.

"(3) Lightly spreading by suitable long-handled rakes in thin layers so that they become mixed.

"(4) A rapid rise of temperature (usually to above 50° C. and never below 45° C.) which persists up to the third turn and kills pathogenes and fly larvæ.

"(5) The restoration of air three times by turning with a digging fork to ensure steady and intense microbial activity and to kill (by burying in the hot mass) any maggots that may hatch out at the exposed cool edges of the heaps. The periods between turning are short enough to prevent any such larvæ developing into flies and to reduce the chances of their crawling out in wet weather to shelter and pupate in the bottom and sides of the trench.

"(6) The replenishment of lost moisture by adding water, if needed, at the times of turning."

The result of the process, which takes from three to eight weeks to complete, is an innocuous dry powder, occupying about half the bulk of the original refuse and weighing about 66 lb. per cubic ft.

The advantages claimed by the authors for the process are the following:

"(1) Low capital outlay and operating costs.

"(2) A net profit from the sale of manure.

"(3) Simple construction of permanent trenches not requiring professional engineering knowledge.

"(4) Economy in disposal ground area.

"(5) The prevention of offensive odours and fly breeding.

"(6) The process can be worked in the open without cover in all seasons, even during continuously wet seasons with 47 and 52 inches of rain and heavy falls of nearly six inches in 24 hours.

"(7) No need of skilled supervision.

"(8) Exceptional cleanliness at the disposal grounds.

"(9) The short period required for complete decomposition to a rich manure in large quantities which is safer for crops than ordinary poudrette.

" (10) The surplus income becomes available for other sanitary measures for improving public health.

" (11) It is equally applicable to large or small communities."

At the end of the Bulletin are printed two " Notes," by Lieut.-Col. J. R. J. Tyrrell, C.I.E., I.M.S. (retd.), Inspector-General of Hospitals and Jails, and Director of Public Health, Holkar State, and Lieut.-Col. M. A. Nicholson, I.M.S., Chief Medical Officer, Central India, each of whom writes with high approval of the process from the public-health point of view.

It is clear that in addition to being a contribution to agricultural practice the process marks a definite advance in the science of sanitation. To quote the authors: " It supplies a ready and practical means of preventing that prodigious waste of fertilising substances which has hitherto increasingly characterised all stages of human civilisation while, at the same time, it constitutes a real advance in sanitation, providing a cheap and profitable solution of the refuse-disposal problem which is still imperfectly solved in most communities in the world. Sanitation need no longer be a luxury confined to large and prosperous towns."

Agricultural Progress in Russia.—The following notes are extracted from a summary of the Report of the 17th All-Union Congress which has been published (in Russian) in *Sozialisticheskoe Rastenievodstvo* (*Socialist Plant Industry*), *Ser. A*, *No. 10* (1934).

After enumerating the various scientific Institutes that have come into being in the U.S.S.R. since the revolution, the Report proceeds to give an account of the work that has been done and the progress made since 1930.

Cotton.—The amount of cotton produced in 1934 was 80 per cent. greater than that obtained in 1913. Although it was supposed to be impossible for cotton to be grown in the Northern Caucasus and Southern Ukraine, yet in 1934 the area under cultivation in those regions has amounted to 350,000 hectares. The Egyptian cotton grown in Azerbaidjan and Tadzhikistan is equal in quality to the best of that imported. The area devoted to Egyptian cotton in 1933 was 80,000 hectares. Special attention has been given to the mechanical harvesting of the crop.

Flax.—The area under flax has increased to 250,000 hectares and the technique of production has been radically reorganised. Whereas in 1928 there were only 18 factories for treating flax, in 1933 there were more than 350 already at work. Progress has been made in selection work and new varieties of flax have been developed.

Tea.—At the time of the revolution there were 900 hectares planted with tea in Georgia whilst in 1933 there were 34,000 hectares. Much research work has been carried out at the Tea Research Institute.

Linseed.—More than 720,000 hectares have been planted with this crop. Both the straw and the flax fibre furnish writing paper of good quality. The yield of cellulose half-stuff amounts to 45–60 per cent.

Sugar Beet.—In 1932 the area under sugar beet was 1·6 million hectares and the yield of sugar amounted to over 2·5 million tons. The waste from the sugar factory is used to some extent for fodder but might be employed for the production of dextrin.

Fruit and Vegetables.—Between 1929 and 1934 the area devoted to fruit and vegetables increased from 2 to 3 million hectares. Much research work is being done in the humid sub-tropics, especially with mandarins and grape-fruit. Peaches occupy about 100,000 hectares and yield about 50 to 90 kilos. per tree. About 500 varieties have been investigated, from which 26 have been chosen for further work. The grape industry of Central Asia has undergone important development. More than 200 local varieties have been tested, among which are some varieties which ripen in from 30 to 90 days and give a crop of about 160 kilos. of fruit per vine. Olives, especially those of the Crimea, are very resistant to frost. On the Black Sea shores of the Caucasus there are about 8,000 olive trees. Almond culture is also in a very favourable position, especially in Transcaucasia and the Crimea. More than 60,000 hectares in Caucasia are covered with chestnut groves. Pistache nuts are grown on 240,000 hectares, about 80,000 of which are in Tadzhikistan. Hazel nuts are produced on about 15,000 hectares in Caucasia ; they contain from 60 to 71 per cent. of fat and 17 per cent. of protein. Wild fruits occur in great variety in various regions and can be employed for grafting or hybridisation. These wild fruits can also be used for pulping and drying. In a small factory in the Maikopsk Section of the Plant Industry Institute over three tons of wild pears, apples, etc., were made into pulp in the course of 1½ months, and half a ton of dried pears were produced. In Siberia and Central Asia there are many valuable and high-fruiting varieties of currants.

Other Crops.—Large areas have been planted with new crops, including sweet clover, sorghum, chicory, Jerusalem artichoke, sweet potato, etc. Soya beans are being cultivated in increasing quantities and the Soya Bean Institute has devised a method of preparing lactic products from the beans, which is now being developed on commercial lines in a factory at Moscow. A new form of lupin has been developed, which is free from alkaloids, and in 1934 more than 60 hectares have been planted with this variety.

Among fibre plants attention is being given to ramie, Italian hemp, kenaf (*Hibiscus cannabinus*), kendyr (*Apocynum* sp.) and kanatnik (*Abutilon Avicennæ*).

Other crops which have been introduced into the sub-tropical areas of the U.S.S.R. include Australian eucalyptus, wattle, cinchona, and the tung-oil tree which is being grown at Batoum. Work has also been started on sub-tropical fruits, such as the persimmon, guava and avocado. Several valuable rubber plants have been found in the Union and are now being grown in plantations. In the past about 12,000 to 15,000 tons of rubber were annually imported, but the demand is increasing greatly. It is hoped to increase the local supply by the manufacture of synthetic rubber from potato spirit.

Notes on Investigations

Pectin.—Pectin has been found to be present in amounts of 14·5 per cent. in the berries of the cloud-berry, 12·5 per cent. in the wild red-currant and 12·75 per cent. in the wild pear. This should obviate the need for importing agar-agar.

Citric acid.—A method of obtaining citric acid from tobacco after the extraction of nicotine has been discovered at the Institute of Tobacco Industry at Krasnodar.

Mexican tomato.—The Mexican tomato (*Physalis æquata*) contains 10 per cent. of pectin with good jellying properties, and up to 1 per cent. of citric acid, whilst the juice contains 5·86 per cent. of sugars and the seeds 23 per cent. of oil. Certain varieties contain the anti-scorbutic vitamin.

Lavender.—By means of selection experiments lavender plants have been grown which give ten times the usual yield, this increase having been effected without appreciable cost.

Badan (*Bergenia crassifolia*).—Badan grows extensively in Siberia and almost up to the Arctic Circle, and yields from 2·5 to 3 tons of dry leaves per hectare. The leaves of this plant yield 12 per cent. of tannin similar to that obtained from gall-nuts. They also contain 18 to 19 per cent. of the glucoside arbutin. After extraction of the tannin, hydroquinone can be obtained from the residue to the extent of about 4·5 per cent. of the dry weight of the leaves. From the tannin a yield of 50 per cent. of gallic acid can be obtained, which is used for the synthesis of important dyes for wool.

Scumpia (*Rhus Cotinus*).—The leaves of this plant contain a tannin similar to that from gall-nuts ; on hydrolysis the tannin gives 85 per cent. of gallic acid. They also furnish 0·5 per cent. of essential oil, containing limonene camphene and dipentene.

Siberian larch.—The bark of this tree gives about 12 to 15 per cent. of a dark red dye resembling Bismarck brown The wood of the tree was first used for paper-making in 1931.

Abies sibirica.—The leaves of this fir contain 1·5 per cent. of an essential oil yielding 30 to 35 per cent. of bornyl acetate, from which synthetic camphor is being prepared. From the tumours on the bark of the tree a balsam similar to Canada balsam is obtained; this is now being manufactured and it is found that at present about 2,000 kilos. suffice to meet the demand of the optical industry.

Seaweed.—The Odessa Chemical Institute are carrying out an investigation on Black Sea seaweed with a view to the manufacture of iodine, agar-agar and alginic acid.

The report contains information regarding the cytological work carried out in the Union during the period 1928–33. The principal work consists of an investigation of the chromosome mechanism of plants, and a brief account is given of some of the research undertaken in this direction.

World Power Conference.—The aim of the World Power Conference is the rational utilisation of the sources of power. The first and second plenary meetings of the Conference were held respectively in London (1924) and Berlin (1930). In addition sectional meetings have been held at Basle (1926), London (1928), Barcelona (1929), Tokyo (1929) and in Scandinavia (1933). The last meeting, which was attended by representatives from thirty-nine countries, discussed problems relating to economic power supply for large-scale industry and for transport on land and sea. The transactions of this meeting, in seven volumes, containing about 4,000 pages, have now been issued by the British National Committee, who are responsible for their publication in Great Britain and the Colonies. They include in full all the papers, general reports and other communications presented to the meeting.

Full particulars of the volumes can be obtained from Messrs. Percy Lund, Humphries & Co., Ltd., 12 Bedford Square, London, W.C.1.

RECENT RESEARCH ON EMPIRE PRODUCTS

A Record of Work conducted by Government Technical Departments Overseas

AGRICULTURE

Soils and Manures

Nigeria.—According to the half-yearly report of the Chemical Section (Southern Provinces) of the Department of Agriculture for January to June 1934, work on the residual effects of varying amounts of lime and limestone on a very acid soil in the Eastern Provinces at Umuahia has been continued, samples being taken every four months. The results show that there is very little loss in the effects of lime two years after the application. The work is being continued for an indefinite period. On visiting the experimental plots certain facts were apparent, viz. :

(*a*) *Calopogonium mucunoides* (a leguminous cover crop) is definitely depressed by the dressings of lime and limestone, the depression being proportional to the quantities of lime and limestone applied.

(*b*) The yields of maize increase in proportion to the lime applied, the increase being less for the larger dressings of lime.

(*c*) There appears to be a tendency for the maize crop to be " laid " on the plots with the heaviest dressings of lime and limestone.

(*d*) After heavy rain, when standing water is apparent on the unlimed plots, those with the heaviest dressings of lime appear to drain better.

(*e*) The limed soils appear darker in colour than the unlimed and consequently carbon and nitrogen determinations are being undertaken to find out how far this is due to increased amounts of organic matter.

(*f*) There appear to be a greater number of stands of maize on the limed than on the unlimed soils.

Arising out of this work, some 15 cwts. of surface soil is being dispatched to Ibadan for pot and germination experiments with and without dressings of lime.

On the farm at Ibadan sampling has been carried out on plots on which the cover crop was (*a*) dug in green, (*b*) cut, allowed to dry, and burnt *in situ*, (*c*) carried off leaving the roots in the soil. The results at present show that the " burnt " plots (*b*) have appreciable higher *p*H values and saturation and exchangeable base contents, but show no particular loss in total nitrogen when compared with the "dug in" plots (*a*). Where the cover crop is carried off (*c*) there is a definite reduction in total nitrogen and exchangeable base content. The carbon-nitrogen ratio is unaffected throughout the plots. There is little difference in yield between the (*a*) and (*b*) plots, but the yield is definitely depressed on the (*c*) plots where the cover crop is removed.

Pot experiments in connection with this field experiment are being carried out.

Profile samples were taken in Benin Province from an area under high forest and from an adjacent area under natural grass. The top foot of the profile showed a *p*H of 5·1 for the forest soils as compared with 4·5 for the grass soil. At lower depths the *p*H of the forest soil dropped to 3·6–3·7, while on the grass soil it showed values of 4·1–4·2.

Work on the Soil Survey of Nigeria continues, but owing to the difficulty of access comparatively few fresh samples have been obtained, and most of the work is confined to the existing samples which are awaiting analysis.

INSECT PESTS

Locusts

Gold Coast.—The Director of Agriculture reports that during January and February 1934 swarms were circling in northern Ashanti in the vicinity of Wenchi, on the Afram plains, and in southern Togoland, and a few scattered swarms invaded the coastal plains between Accra and Ada. In March they tended to return north. Some swarms matured during March and oviposition took place on a small scale in southern Togoland and Trans-Volta district.

Movements of swarms since the commencement of the outbreak have been mapped out with a view to future publication. Swarms appear to be influenced by humidity. From July to September humidity is too high to be favourable for locusts in all parts of the Colony. In October, when humidity commences to drop in the north, swarms invade the Northern Territories, gradually moving southwards as the humidity decreases. From December to January all swarms are located south of the 8th parallel, conditions farther north being too dry. From March onwards as humidity increases in the north they again move northwards. This cycle has taken place every year since the commencement of the outbreak.

BEVERAGES

Cocoa

Gold Coast.—The Director of Agriculture has furnished the following report on investigations carried out during the period January–June 1934.

(*a*) *Size of Beans.*—During 1932–33 a statement was made that the size of Gold Coast beans was progressively lessening through degeneration and senility of the trees. The Department, whilst admitting that the beans in that year were smaller, probably owing to drought, did not agree that there was any progressive decrease in size. Careful records taken over two years are now available and are given in the table below :

Monthly Means of the Number of Beans per 14 Cubic Inches in all Shipments of Cocoa

Month	1932–33	1933–34
June	142·0	143·6
July	139·9	138·7
August	136·1	139·8
September	128·9	135·5
October	129·6	125·4
November	132·0	123·3
December	134·2	123·0
January	135·2	123·7
February	137·7	126·7
March	138·1	129·2
April	141·0	128·4
May	145·0	131·2

The table shows that there is no foundation for the statement that there is a progressive decrease in bean size, and that on the contrary there has been a very definite increase.

(*b*) *Purity of Cocoa.*—The collection and analysis of figures for purity, obtained by sampling cocoa exported at the ports, has been continued. The record shows that during the major crop period, i.e. October–May, there has been a decline in percentage purity during 1933–34, and the figures are given below in comparison with those of previous years [1] :

Year	Mould	Germinated.	Slate	Weevil	Other	Purity
1927–28 .	3·4	3·3	4·8	0·6	0·6	88·8
1928–29 .	3·8	2·4	5·7	0·6	0·8	89·0
1929–30 .	3·3	1·2	6·4	0·7	1·2	88·5
1930–31 .	3·6	2·2	4·6	1·0	0·8	89·8
1931–32 .	4·1	2·6	5·2	0·6	1·7	89·7
1932–33 .	2·4	2·2	5·1	0·5	0·9	90·1
1933–34 .	2·6	3·5	5·8	0·5	0·7	88·6

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[1] It will be observed that the figures for 1927–28 to 1932–33 differ slightly from those published in the last report (this BULLETIN, 1934, **32**, 137) ; the latter represent the purity over the annual export period, October 1–September 30.

(*c*) *Cocoa-weevil* (*Aræcerus*).—Continued investigation into the activities of this pest has shown that infestation is almost entirely due to faulty preparation and storage. The adult weevil is attracted to the drying trays and normally egg-laying takes place in beans of between 10 and 30 per cent. moisture content: under-fermented beans being preferred. Very few weevils completed development in tests on well-fermented beans which had been dried below 8 per cent. moisture, and kept below that figure. Normal sun temperatures have been proved to be sufficiently high to destroy eggs in beans exposed to sunlight for 2–3 hours; so that provided beans are carefully raked over during exposure during the day almost complete mortality among the eggs should result. In storage there is little danger from the weevil if the building is sufficiently dry to prevent beans taking up excess moisture from the atmosphere.

(*d*) *Cocoa-moth* (*Ephestia*).—Experiments have been continued although this year the infestation has not been high, probably owing to much greater attention being given to the cleanliness of stores. It has now been proved that under-fermentation of beans favours the increase of the moth. Few larvæ are capable of penetrating the testa of a well-fermented bean and thus completing development on the cotyledons; but on the other hand the testa of an under-fermented bean is frequently eaten and in many cases nearly stripped off. The minute debris in old cocoa bags is also an important source of reinfestation from season to season, some 19 per cent. of larvæ in an experiment surviving on such material.

(*e*) *Co-operative Society Cocoa.*—The purity of cocoa prepared by the Co-operative Societies, under the ægis of the Department, continues to be high and the results of examination during the past season are shown in tabulated form for all districts below:

District	Tons Cocoa Sold	Purity per cent
Kumasi	473	97·6
Bekwai	336	97·4
Ofinso	393	98·0
Efiduasi	527	98·2
Juaso	120	98·4
Sefwi	167	97·7
Cape Coast and Saltpond	113	97·6
Winneba	299	97·1
Oda-Kade	291	96·0
Koforidua	154	96·7
Akwapim	9	96·7
Kwahu	152	95·8
Nsawam Kibi	438	96·2
Krobo	298	96·7
Peki	200	97·2
Togoland	114	97·1
	4,084	

Nigeria.—Mr. O. J. Voelcker, Botanical Section, Southern Provinces, has furnished the following report on his investigations on cocoa, carried out during the six months January–June 1934.

The multiplication of selected trees on Moor Plantation has been continued. In the initial stages this is carried out by obtaining seed which has resulted from controlled pollination, but attempts to bud small plots of the best trees are to be made shortly. It was realised that the original selections made in 1932 included a rather high proportion of trees yielding small beans. Since then increasing attention has been paid to the size of the beans, and a number of other trees having this desirable characteristic were included in the 1933 selfing programme.

In a paper by F. J. Pound on " Criteria and Methods of Selection in Cacao " (*Second Annual Report on Cacao Research*, 1932.—Trinidad, 1933), notes are given on the criteria for the selection of trees worth multiplication. Briefly, it is suggested that, pending further investigation, such trees should combine size of bean and yield in such a ratio that the yield in pounds of dry cacao per tree should be equal to or greater than the number of pods required to give 1 lb. of dry cacao. Thus a tree yielding 7 lb. of dry cacao and requiring seven pods to make 1 lb. of dry cacao would be as valuable as a tree yielding 12 lb. of dry cacao but requiring twelve pods to make 1 lb. of dry cacao. Within limits, trees which have only a small yield but a large bean are as valuable as high-yielding trees with small beans ; the lower limit provisionally fixed for Trinidad is twelve pods to the pound. It is interesting to compare West African Forastero cacao with these standards, and more particularly so the Moor Plantation selections. The following table shows the characteristics of these selections (see page 442). Similar figures have recently been published in a paper on " High-yielding Cacao Trees at Kpeve " (*Gold Coast Farmer*, Vol. II, No. 3, July 1933).

It will be noticed that two of the Moor Plantation selections—Trees 38 and 9—are outstandingly good. If the yield figures for the average over eleven seasons are taken, these two trees, together with Tree 7, alone pass the Trinidad standards, but if the yield figures for 1932–33 only are examined, nine trees pass. None of the Kpeve trees, some of which are considered worthy of multiplication in the Gold Coast, reach Trinidad standards.

The table also shows what high yields can be expected from West African Forastero trees : to consolidate and improve this heavy-yielding characteristic is the basis of selection work in Nigeria.

Tree No	No of pods per lb of dry cacao.	lb of dry cacao per tree.	
		1921–22 to 1931–32 Average of 11 seasons	1932–33
38	9·3	14·0	26·4
9	10·5	13·1	26·0
30	11·1	9·5	22·8
213	12·3	7·8	16·4
13	10·5	9·2	15·8
118	11·6	5·9	15·6
35	12·3	7·8	14·4
75	13·0	8·2	14·3
15	12·3	6·6	14·2
108	11·1	6·7	13·3
7	9·7	9·8	12·6
104	11·6	8·2	12·5
86	11·6	7·4	12·0
162	11·6	7·7	11·4
53	11·6	7·5	11·3
184	13·7	6·7	10·0
95	12·3	10·2	9·8
192	11·1	6·2	9·8
50	13·7	6·2	9·0

Investigations into the possibilities of growing superior types of cacao have not been overlooked. The high price of Trinidad and South American cacaos is based largely on the finer flavour of the beans. This finer flavour is associated with the white or light-coloured beans. A few trees which throw these beans are growing on Moor Plantation, and steps are being taken to propagate them ; but it is anticipated that any increase in price obtained for the product would be counterbalanced by the probable reduction in yield. Seedlings from three trees of outstanding merit in Trinidad were received in 1933 and have successfully passed a severe dry season in nursery beds. The generous assistance of the Director of the Royal Botanic Gardens, Kew, made it possible for the seed to be germinated there and examined for witchbroom disease before being forwarded to Nigeria.

As regards the yields over the entire plot of yellow-pod Forastero cacao these were larger in 1933–34 than in the previous season. The following table gives the yields over the past eight seasons, which are thought to be slightly smaller than those on native farms :

Season.	Yield of Dry Cacao per acre.
1926–27	622 lb.
1927–28	479 „
1928–29	508 „
1929–30	914 „
1930–31	1,251 „
1931–32	1,102 „
1932–33	774 „
1933–34	847 „

The plot was planted in 1912, and has an area of 2·22 acres, with 166 trees per acre.

During the 1933–34 season the average yield of dry cacao per tree was 5·1 lb., whilst the average number of pods per tree was fifty-six.

The following report on investigations carried out by Mr. J. West, Botanical Section, Southern Provinces, on the control of Black Pod of cacao, has also been supplied.

Experiments (see report for January 1933) were laid down at Ajia in 1931, and three main-season crops have now been harvested. The details of the plots may be summarised as follows :

Plot		Acreage	No of Trees	Trees per acre (nominal)	Treatment
1	Treated .	0 34	162	477	Bordeaux Mixture Spray
	Control	0 25	162	648	—
2	Treated .	0 21	96	457	" Cupryl " Copper Dust
	Control .	0 20	96	480	—
3	Treated .	0 47	252	536	" Olite " Sulphur Dust.
	Control .	0 34	252	741	—
4	Treated .	0 89	432	485	Clean Sanitation
	Control .	0 78	432	554	—

It will be seen that, though the treated and control portions of each plot have the same number of trees, they are not equal in size. Originally, each treated portion was thoroughly pruned and thinned out to a more reasonable spacing than that existing on the normal farm. Extra trees were then taken in to correspond to those cut out, and the respective acreages were revised.

Spraying and dusting are carried out in March, June and August. Last year, owing to the wet conditions, the usual short dry-season application in August was not made. In the past, the dusts have been applied with knapsack bellows machines, which are both awkward and unsuitable for cacao. Recently, however, a rotary blower type of duster has been tried out with promising results. The spraying was similarly done with knapsack machines. A portable bucket type of spray apparatus has very recently become available from locust control work, which should be a great improvement. Both spraying and dusting should now show considerable savings in time and labour.

In Table I the total weights of beans, including both healthy and diseased, are expressed as pounds of dry cacao per acre for the main and mid-season crops. If the figures given for each harvest are added up, it will be seen that the differences between respective treated and control portions is generally in favour of the treatments. This may be taken to represent the increase in total yield which has followed the stimulation due to the original thinning.

In Table II the weights of healthy beans for each harvest are expressed as pounds of dry cacao per acre. If these figures are added as in Table I, they all show an increase in favour of the treatments. This increase may be taken as expressing the results of both pruning and thinning, and also spraying, dusting and good sanitation. It must be borne in mind that this average figure is the result of three years' harvests, so that it should be divided by three to give the annual increase due to treatments, which is not quite true, since the 1934 mid-season crop has not yet been taken.

The figures given in Tables I and II show that, in the Ajia area, the 1933–34 crop was generally considerably below that of the previous two years. At the same time, the treated plots did not fall down so heavily as the controls, possibly owing to the original thinning out.

Table III gives the percentage of diseased beans by weight in the main and mid-season crops harvested to date. Generally speaking, the spray and dusts have reduced the amount of disease, more especially in the main crops. As already mentioned, no spraying or dusting was done in August last year. This may account for the rise in the treated portion of Plot 1. Plot 1 is situated on the slope of a steep valley, with the treated portion on the lower and damper part. In Table III, the amount of disease is expressed in weights of beans and not in numbers of black pods, because although the pod may show an outer or husk infection, the beans inside will be healthy. Whether such beans become infected is largely a question of regular harvesting. Table III also shows that the actual losses due to black-pod diseases seldom rise to 12 per cent. in the control plots, provided the crop is harvested regularly.

TABLE I

Ajia Plot Yields : Total Weights of Beans, Healthy and Diseased, expressed as lb. of Dry Cacao per acre

Plot		1931–32		1932–33		1933–34	Difference by Totals.
		Main	Mid	Main	Mid	Main	
1	Treated	521	249	874	292	579	+ 579
	Control	552	267	587	86	444	
2	Treated	940	215	766	92	504	— 60
	Control	916	125	959	110	467	
3	Treated	1,354	388	1,256	318	711	+ 403
	Control	1,484	317	1,293	235	295	
4	Treated	797	357	794	140	585	+ 324
	Control	969	226	662	97	395	

Average + 312
Annual Average + 104

TABLE II

Ajia Plot Yields : Total Weights of Beans, Healthy Only, Expressed as lb of Dry Cacao per acre

Plot.		1931–32		1932–33		1933–34	Difference by Totals
		Main	Mid	Main	Mid	Main	
1	Treated	504	247	856	286	553	+ 634
	Control	518	261	523	77	433	
2	Treated	864	209	745	92	498	+ 17
	Control	802	120	907	110	452	
3	Treated	1,284	379	1,216	309	683	+ 535
	Control	1,362	312	1,160	231	271	
4	Treated	767	340	750	136	572	+ 298
	Control	929	217	631	94	385	

Average + 371
Annual Average + 123

TABLE III

Ajia Plot Yields Percentage of Diseased Beans by Weight in Main and Mid-season Crops

Plot		1931–32		1932–33		1933–34
		Main	Mid	Main	Mid	Main
1	Treated	3·4	1·0	2·2	2·6	4·6
	Control	6·2	1·9	10·8	10·0	2·3
2	Treated	8·1	2·9	2·7	[1]	1·2
	Control	12·4	3·4	5·4	[1]	3·2
3	Treated	5·2	2·4	3·2	2·6	3·8
	Control	8·2	1·6	10·3	1·6	8·1
4	Treated	3·8	4·6	5·5	2·4	2·1
	Control	4·1	3·9	4·7	2·8	2·5

[1] *Fractional values only*

CEREALS

Rice

Gold Coast.—The Director of Agriculture, in a report covering the period January–June 1934, states that the Government Mill at Esiama continued to function in what has been a difficult season, owing to the extremely low price at which foreign rice can now be dumped into the country. A record amount of paddy was brought in for treatment and the results in comparison with past years can be seen in the following table :

—	Tons of Paddy Received	Villages Contributing	Cost of Milling per ton of Paddy	Price to Grower per 100 lb Rice
			£	
1926–27	35·3	13	7·96	14*s*
1927–28	128·4	15	2·38	14*s*.
1928–29	191·2	16	1·69	14*s*
1929–30	106·2	26	2·18	14*s*.
1930–31	289·2	38	1·00	14*s* –12*s*
1931–32	413·6	47	1·03	9*s* –15*s*
1932–33	354·0	37	1·05	10*s* –10*s*. 5*d*.
1933–34	426·0	35	0·98	7*s* 6*d*.

A beginning has been made with the isolation of high-yielding strains, one of which has been planted out by a few farmers under supervision of the Department.

Sierra Leone.—Reference was made in this BULLETIN (1934, **32**, 140) to the experiments on the control of the weevil, *Calandra oryzæ*, which are being carried out by Mr. C. Hargreaves, Entomologist to the Department of Agriculture. In his report covering the period January–June 1934, Mr. Hargreaves gives the results of a further experiment in this direction. Fumigation with carbon bisulphide, used at the rate of 5 lb. per 1,000 cubic feet for a period of forty-eight hours, was found to be not effective : apparently some of the weevils in the pupal stage had survived as a few live adults were seen some days afterwards.

LEGUMES

Nigeria.—The report of Mr. J. West, Botanical Section, Southern Provinces, for the period January–June 1934, contains the following account of work carried out on various edible beans.

The past season proved to be an extremely poor one as regards the yields of edible beans on Moor Plantation. As the result of selection work commenced in 1927, a strain of local Popondo (*Phaseolus lunatus* var.) had been multiplied sufficiently for large-scale experiments to be undertaken. Consequently it is most disappointing that such poor yields should have been obtained from 13·5 acres on the plantation sown with this selected seed. The yields ranged from 92 lb. to 359 lb. of unshelled beans per acre, as compared with yields of from 400 lb. to 1,257 lb. which had been obtained in previous seasons. This drop in yield was equally shown in the bean selection plot, where annual individual plant selection is practised.

	1928–29	1931–32	1932–33	1933–34.
Number of plants grown	—	10	66	61
Average number of seeds per plant . .	—	565	201	78
Highest individual yield	505	858	950	271

It would appear that there was a yield failure due to climatic factors, and not that a previous good season had led to unduly optimistic expectations. On Moor Plantation the months of October, November and December showed increases respectively of 1·92, 2·15 and 1·36 in. of rain over the previous twenty-four-year average. The excess occurring at the time when flowering and pod-setting take place quite possibly explains the yield failure.

During the past season thirteen varieties of butter beans from the United States were tried out in the selection plot. The five bush forms all proved to be failures, but three of the climbing or pole forms, viz. Small White, Willow Leaf and Florida Butter, showed considerable promise. Their yields equalled or surpassed the best local types, and their cover, though susceptible to chlorosis, was heavy and durable. The ultimate object of this selection work is to produce a heavy-yielding butter bean of the Madagascar type which will command a good export price. Popondo is a heavy yielder, but the seeds tend to suffer from "weathering." The Limas, such as the American butter beans, while excellent yielders, have a smaller seed which is not so valuable commercially. Attempts are therefore being made to cross Popondo with the best American varieties and with Madagascar, with the object of improving both yield and seed quality. Naturally, it will be several years before the success of this work will be known.

ROOT CROPS

Cassava

Gold Coast.—According to the report of the Director of Agriculture for the period January–June 1934, work has been continued in connection with the attempts to find varieties of cassava immune to mosaic disease. The Economic Botanist has worked on a large number of types growing at Kumasi, which now include seventy-seven local varieties and twenty-eight imported ones. In an endeavour to breed a resistant type those strains found to be most resistant have been used as one parent in cross-pollination. A satisfactory technique has been evolved and 1,100 buds cross-pollinated. From these 84 fruits resulted containing 196 seeds. The percentage of fruits is low but varies considerably with different varieties. Germination of seed is erratic and uncertain, but several types are now established and growing well. Their future behaviour will be of great interest.

Nigeria.—Mr. J. West, Botanical Section, Southern Provinces, reports as follows regarding his investigations carried out during the period January–June 1934.

A collection of local cassava varieties was made in 1932. Samples from all over Nigeria were sent to Ibadan by the Superintendents of Agriculture at the outstations. These samples are being classified both on vegetative characters and on analyses of prussic acid content made by the Agricultural Chemist. Yields, time to maturity and tuber quality are other factors under consideration. The main object of this investigation, however, is the production of suitable bitter and sweet varieties which will be immune from or resistant to the mosaic disease. As in other colonies along the West Coast, this disease has appeared along the seaboard in recent years, and is spreading slowly inland. Mosaic of cassava is a serious disease in that, when well established, it reduces yields by one-half or more. The rate of spread northwards through the country appears to be comparatively slow, but the time will come when it will assume economic proportions.

None of the Nigerian varieties are immune to mosaic, and only a few show any degree of resistance. Attempts are therefore being made to introduce immune varieties from abroad. With this end in view, it is hoped to co-operate with the Agricultural Departments of the Gold Coast, Sierra Leone and the West Indies. It is possible that, while immune varieties may be introduced, they will not prove suitable, in which case an attempt will be made to hybridise them with the local types. Such work will naturally require a number of years for completion.

Cocoyams

Gold Coast.—The Director of Agriculture, in a report covering the period January–June 1934, states that investigation has been actively pursued into the cocoyam root rot, but little progress has been made in control. It is now clear that the cause is the fungus *Rhizoctonia solani*, which, however, can only attack the cocoyam in the presence of certain unfavourable soil conditions. These appear to be associated with nitrate deficiency, but applications of nitrates in the field have not so far been effective.

Yams

Nigeria.—The following report on work carried out during the period January–June 1934, by Mr. J. West, Botanical Section, Southern Provinces, has been supplied.

Varietal Studies.—A study of the yam varieties grown throughout Nigeria was begun in 1932. Collections of the local varieties were made by the Superintendents of Agriculture at each out-station and forwarded to Moor Plantation. At the moment 208 samples are under observation, though it is obvious that a number of these are replicates. Experimental plots have been laid out in which the samples of each type are grown for comparison *inter se.* Each sample is grown in duplicate, one lot staked and the other unstaked. Should otherwise suitable types be found which yield equally well whether staked or not (and such types are not unknown elsewhere), they would prove of considerable economic importance. Storage tests and analyses of the tubers are being carried out as material becomes available.

Dry Rot of Yams.—In the farming district round Ibadan and Ilorin there exists a disease which attacks the yam tubers. On the Department's farms in both stations the disease has of recent years assumed serious proportions. Investigations during the past eighteen months have given the following tentative results.

This tuber rot has so far only been reported from the Western Provinces ; it has not been found in the Eastern Provinces. Analyses of soils by the Agricultural Chemists suggest that alkaline soils and soils having a high organic matter content may tend to increase the incidence of the disease. Observations at Ilorin and on Moor Plantation suggest that the disease will be less severe when yams follow cereals and cotton than with any other of the rotations in use. Where crops of yams are grown on the same plots in successive years the disease rapidly builds up to serious proportions. It also appears to be more severe in poorly drained soils and, at Ilorin, in land which has received applications of farmyard manure.

Observations both in the field and in the laboratory indicate that the disease has its origin in the soil. Young tubers, which outwardly appear healthy, when skinned are found to have small pale yellow lesions just beneath the skin. The primary lesions generally develop slowly, assuming a dark brown to black colour. They are invariably found to contain large numbers of eelworms. In the laboratory, inoculations of healthy yams with this eelworm have proved successful. In the later stages the whole periphery of the tubers becomes involved in a decay, in which strains of *Rhizoctonia solani* and *Fusarium oxysporum* are prominent. Dr. T. Goodey, of the Institute of Agricultural Parasitology, St. Albans, has identified the eelworm as *Hoplolaimus bradys* Steiner and LeHew. This eelworm was recently found in diseased yams imported into the United States and Jamaica. The actual damage done by *H. bradys* is probably not severe, but its attack opens the way for infection by various fungi and bacteria whose activities completely destroy the tuber.

Various agricultural methods are now to be tried out on Moor Plantation with the object of controlling the eelworm. It will naturally take some time, however, to show the effectiveness of these methods. In the meantime, each sample of the yam collection, already mentioned, is being subjected to the possibilities of infection in the field, with the object of discovering any which are resistant or immune.

FRUITS

Bananas

Gold Coast.—The Director of Agriculture, in a report covering the period January–June 1934, states that trial shipments to the English market on a small scale with the varieties Gros Michel and Canary have been continued (see this BULLETIN, 1934, **32**, 143), and have so far been uniformly successful. Consignments, which have contained as a rule more Canary type than Gros Michel, have been packed with paper bags round the bunches, this having been found the most convenient and economical method. Bunches are harvested within twenty-four hours of shipment in a stage where the proximal fingers have just lost their angularity, while the distal ones still retain this feature. The cut stalks are smeared with vaseline as they are trimmed just before shipment.

With the Canary type of banana, on a 2½-acre experimental block, it was found that 85 per cent. of the stools fruited during a year, and of these three-fourths were produced during the season July–November. The numbers of "payable" bunches produced in plots of the Canary and Gros Michel types on two Experimental Stations, Asuansi and Kpeve, are of interest, and together with the average weights of bunches are given in the two tables following:

Payable Bunches. Percentage of Total Produced

	Asuansi	Kpeve	
	Canary.	Canary	Gros Michel.
Over 9 hands	7	12	13
9 hands	15	27	28
8 ,,	28	25	25
7 ,,	28	19	20
	78	83	86
Non-payables	22	17	14
	100	100	100

Average Weight of Bunches in lb.

	Over 9 hands.	9 hands.	8 hands.	7 hands.
Asuansi Canary	62	51	43	33
Kpeve Canary .	58	49	40	30
,, Gros Michel	46	46	48	40

The period from the time of fruit-setting to harvesting is some 100 to 116 days.

A serious wilt of bananas near Takoradi was carefully investigated in view of the danger of Panama disease, but was found to be due to the attack of nematode worms facilitated by most unsuitable soil conditions. A few cases of *Marasmius* stem rot, not an important disease, were also recorded.

Citrus

Gold Coast.—The Director of Agriculture, in a report covering the period January–June 1934, states that the work of propagating both imported and good local types of grape-fruit, oranges, lemons and tangerines has been continued. In the actual budding work Rough Lemon has given the best results as a root stock, and grape-fruit and lemons have been the easiest types of citrus to bud. Limes have proved difficult material. In the event of an export of fresh fruit becoming a possibility it would be necessary to concentrate on not more than two varieties, if not on one alone, and the behaviour of the numerous types is being carefully studied from this point of view.

Nigeria.—Mr. E. H. G. Smith, Botanical Section, Southern Provinces, reports as follows regarding his investigations on fruit, carried out during the period January–June 1934.

Work with fruit is confined mainly to citrus ; and with the latter crop to the introduction, multiplication and trial of new and superior varieties. The American introductions mentioned in the January–July 1933 report (this BULLETIN, 1933, **31**, 415) have done well, and no further losses have occurred. A second introduction of citrus budwood (*loc. cit.*), packed in thermos flasks, was made from Trinidad, through the courtesy of the Director of Agriculture of that Colony, and while the orange varieties failed, Trinidad Marsh Seedless and Foster grape-fruits have been successfully established. A similar introduction was attempted from British Honduras, but failed on account of delay in transit ; though it is probable that in this instance the distance involved, in conjunction with the lack of a rapid means of transport, would render any attempt abortive. Through the generous assistance of Dr. Walter T. Swingle, seeds of several tangelos, a pomelo, and of the trifoliate orange, were obtained from the United States Department of Agriculture, and were successfully established. It was also considered desirable to introduce some fresh citrus stocks, and seed has been very kindly supplied by the Departments of Agriculture in Trinidad and Sierra Leone. In connection with the recent citrus (and also cacao) introductions, invaluable assistance has been received from the shipping company, Messrs. Elder Dempster Lines Ltd.

The trees propagated from citrus budwood obtained from Sierra Leone, together with some local selections, planted out a year ago at Agege and Ibadan, have done well, and but few losses have been experienced. At Agege, Aphis infestation of young citrus has been found to be troublesome, and the local Superintendent of Agriculture has found spraying necessary. This may prove to be a handicap to the extension of citrus-growing in that area, as the spraying of small plantings spread over a wide area would be a formidable undertaking. The citrus stock trials (mentioned in the report for July 1932) have done well, and in the Ibadan trial a few trees are commencing to fruit.

Termites have been found to be troublesome at Ibadan. These are prone to eat the bark of young citrus trees just about ground level, and unless discovered, may completely ring-bark the trees. It is necessary to keep a fairly constant watch for such attacks, as these insects are rapid workers once a tree is affected. The treatment is fully to expose the parts attacked and to paint the wood with a disinfectant. Naturally, this trouble most usually occurs during dry weather, and the otherwise beneficial grass mulch during the dry season has had to be dispensed with on this account. Further multiplication of the new varieties is proceeding as fast as budwood becomes available, and other experimental stations are being supplied with local reproductions of the introduced plants.

Sierra Leone.—Mr. C. Hargreaves, Entomologist to the Department of Agriculture, in a report for the six months ending June 30, 1934, mentions, in connection with the list of host-plants of fruit-piercing Lepidoptera referred to in this BULLETIN (1934, **32**, 146), that *Othreis fullonica* was found on *Dioscoreophyllum tenerum* and not on *D. leonense* as previously reported. Further host-plants discovered during the first six months of 1934 are *Anua* (?) *producta* Holl. on *Combretum comosum*; *Othreis fullonica* Linn. on *Stephania Dinklagei* and *Triclisia patens*; and *O. materna* Linn. on *Rhagiocarya racemifera.*

SPICES

Pepper

Nigeria.—Mr. O. J. Voelcker, Botanical Section, Southern Provinces, reports that, on the suggestion of the Economic Botanist, Kew, cuttings of three different varieties of peppers (*Piper* spp.) grown in Madras were received in 1933. These have been planted against Para rubber trees and have made satisfactory growth. The leaves are larger than those of locally grown peppers. The three varieties are *Piper nigrum* var. *Kalluvalli*, var. *Cheriakodi*, and var. *Balamcoota.*

FODDERS

Lucerne

Nigeria.—Mr. J. K. Mayo, Agricultural Botanist, Northern Provinces, reports as follows regarding the investigations carried out during the period January–June 1934.

The various types of lucerne introduced through the agency of the Imperial Bureau of Plant Genetics and grown at Zaria survived the dry season fairly well without any watering, though in another experimental plot, on land which is heavier and inclined to waterlogging, most of the plants died. As soon as the rains came all varieties made rapid growth, and most of them have been flowering profusely for the last two months, but no ripe seed has been obtained. This is very disappointing, for unless seed can be obtained there is little hope of lucerne being of any practical use here.

OIL SEEDS

Ground-nuts

Gold Coast.—The Director of Agriculture, in a report covering the period January–June 1934, states that a campaign to stimulate the production of ground-nuts in Northern Ashanti was carried out during 1933 and resulted in an increase of some 2,000 acres in cultivation. A Nigerian type of seed was issued to the farmers concerned. It was hoped that the surplus produced would result in a small export, but prices in internal markets were higher than those offered by exporting firms and it is evident that the local market is not saturated.

The expression of oil from the Nigerian type of nut was undertaken by the Department and some 5 tons of nuts treated. The rate of extraction at 34·3 per cent. of oil was low, and less than that obtained earlier from Northern Territory ground-nuts, possibly on account of some immaturity among the nuts treated. Excellent oil was produced, which would cost some £27 per ton (excluding supervision) on the assumption that nuts could be purchased from growers at ⅝*d.* per lb. The oil sold readily on the spot at £34 per ton. There is a considerable import of edible oil into the Gold Coast which might readily be replaced by local production. The residual cake left after the oil has been expressed from the nuts is valuable as a stock food and was much appreciated by the Department of Animal Health.

Nigeria.—Mr. K. T. Hartley, Agricultural Chemist, Northern Provinces, reports as follows regarding investigations carried out during the six months January–June 1934. The oil content of a high-yielding strain of ground-nuts, selected by the Botanist from the Zaria upright type, has been determined on samples of the strain grown at a number of different farms in the Northern Provinces. This oil content has been compared with that of the unselected Zaria nuts grown on the same farm and with that of samples taken from the Trading Companies' stocks awaiting export at the same station. The following table shows the mean oil content (on a dry matter basis) of three samples of each kind from each station. The figure in brackets represents the range between the highest and lowest individual determinations. As would be expected, this is largest in the case of the trade samples and lowest in that of the selected strain.

Place	Selected Strain	Unselected Type	Trade Samples
	Per cent	*Per cent*	*Per cent*
Daura	51 11 (0 84)	(No samples)	52 46 (1 12)
Kano	50 86 (0 61)	50 49 (0 80)	50 60 (1 50)
Kafin Soli (Katsina)	50 66 (0 50)	50 92 (1 09)	49 83 (1 32)
Sokoto	50 33 (0 60)	48 71 (1 73)	52 60 (0 20)
Maigana (Zaria)	50 27 (0 69)	50 72 (0 11)	48 27 (0 29)
Samaru (Zaria)	49 76 (0 48)	48 27 (0 36)	49 11 (1 50)
Gusau	48 70 (0 96)	47 80 (0 80)	49 77 (2 20)

It will be seen that the high-yielding strain has not been developed from the unselected type at the expense of oil content. The variation from 48·70 per cent. at Gusau to 51·11 per cent. at Daura is, however, remarkable. There is no consistent relationship between the selected strain and the local trade samples, but at one or two places the superiority of the local samples is sufficient to suggest the need for further work. This year samples of nuts collected in the Gusau and Sokoto areas are being grown at other stations to see how far their oil contents are affected by locality. If the Sokoto type remains markedly high it should be useful material for further selection.

Oil Palm

Nigeria.—The following report has been furnished on investigations carried out by Mr. E. H. G. Smith, Botanical Section, Southern Provinces, during the six months January–June 1934.

Oil Palm Selection.—Planting in the field was begun in 1930 of the first self-fertilised generation of the Calabar oil palm selections, and in that year a total of fifteen acres was established, divided between the experiment stations at Benin and Umuahia. These palms commenced to fruit early in 1933, when approximately three and a half years old, and by the end of February 1934, nearly two-thirds of the trees had produced ripe bunches. During the past year of small initial yields all fruit forms are grouped together, and fruit weights are ignored. The grouped yields for 1933, average age of the palms four years, are as follows :

	No. of Bunches	Weight of Bunches lb.
Benin	666	1,838
Umuahia	491	1,237

As the acreages in each instance are approximately equal, that at Umuahia being slightly the greater, it follows that the Benin palms have given an appreciably better return. This difference in yields is of interest, as it is probably accounted for largely by the climatic conditions of the two farms. At Umuahia the average annual rainfall is higher than that at Benin, but the Benin climate is definitely the more humid and the rainfall is more evenly distributed. In each instance the palms are growing on land cleared from bush, but without stumping, and a cover crop of *Calopogonium* is maintained.

Inheritance of Fruit Form in the Oil Palm.—During the next few years considerable data bearing on the inheritance of fruit form in the oil palm will become available in Nigeria. Present indications, both here and elsewhere, suggest this to be of a fairly complex character. Oil palm investigations in Sumatra are ahead of those in this country, but unfortunately little information of the recent Sumatran results is obtainable. Dealing with the inheritance, Schmole (" The Selection of Oil Palms," Vol. IV, *Agricultural Papers, Proceedings of the Fourth Pacific Science Conference, Java,* 1929) states that, " It is, however, certain that with self- as well as with cross-pollination, palms with *tenera* fruit form can produce an offspring with *pisifera* (shell-less), *tenera* (thin-shell) and *dura* (deli type), as well as *macrocarya* (very thick-shell) fruit forms." Until the various types are represented by much larger numbers of palms on the experimental farms, our classification of shell thickness must remain of a tentative nature only : the present criteria are the ease of cracking the nuts and the presence or absence of a well-marked ring of coarse fibres in the mesocarp. It seems possible that there is a gradation in shell thickness : it is obvious that intermediates exist between the usual forms, and these will have to be recognised in future. Further, it has been found that in some instances the preliminary classification of fruit form has had to be revised when the fruits from later bunches are examined. At present we group both *dura* and *macrocarya* (if there is ultimately found to be true distinction between these) as thick-shell, and, similarly, include the rare shell-less (*pisifera*) palms with the thin-shell class. Such is satisfactory for a preliminary classification, but is recognised as being incomplete. Unfortunately, a more detailed study is as yet impossible. A rough classification of fruit form is now presented for the first generation of self-fertilised palms that have already fruited :

(i) Planted as thick-shell: Thick-shell 260, Thin-shell 11.

(ii) Planted as thin-shell : Thick-shell 108, Thin-shell 136.

(iii) Planted as green-fruited : Green-fruited 134, Non-green-fruited 61.

For comparison a similar summary is given of the incidence of fruit form where natural cross-pollinated seed was planted. These figures are obtained from plots at Calabar, Benin and Umuahia :

(i) Planted as thick-shell : Thick-shell 508, Thin-shell 40.

(ii) Planted as thin-shell : Thick-shell 304, Thin-shell 119.

(iii) Planted as green-fruited : Green-fruited 82, Non-green-fruited 96.

It would be premature to attempt to draw definite conclusions from the above tables. But as a generalisation, it may be said that in the first generation of self-fertilised palms a considerable increase in the proportions of the thin-shell and green-fruited fruit forms has occurred, and that, as would be anticipated, there is some diminution in the number of thin-shell palms thrown from thick-shell seed. As a point of interest it may be added that instances of shell-less and of green-fruited mantled palms have already been observed in the progeny of trees that did not exhibit these characteristics. This work on the inheritance of fruit form is of great practical value in connection with the production of improved, and ultimately of pure, oil palm seed for establishing native plantations. The respective merits of the best types of thick-shell and thin-shell palms are not as yet fully ascertained, though there seems to be little doubt that the best thin-shell types will be the palms of the future. At present the Eastern plantations with their Deli palms possess an appreciable advantage over the

African thick-shell types, but given a satisfactory development of thin-shell forms, which seems to be probable, this advantage would tend to disappear. The present Nigerian problem is to increase the proportions of the thin-shell palms so that the merits of these may be fully explored and that seed selection from the best individuals only may proceed. On the figures given above, it is now only possible to anticipate approximately one thin-shell palm in four where natural cross-pollinated thin-shell seed is sown, although a proportion of at least one in two is attainable with self-fertilisation, but such a process is impracticable for a bulk seed supply scheme. It is possible that this estimate of one in four is rather on the pessimistic side, as a greater proportion of thin-shell types has been recorded in other countries, and this proportion would be partially governed by the actual density of thin-shell palms in any population from which seed is taken. For instance, there is a very reasonable chance that a higher proportion of thin- to thick-shell palms will be given by the natural seed from the Department's thin-shell palms of the first self-fertilised generation, and seed from these palms will shortly become available in some quantity. Proposals are under consideration for isolated plots of the thin-shell forms to produce improved seed in quantity for native plantations. But for these it is not possible to await the production of pure breeding strains—such strains cannot be attained for some years—and as a beginning, self-fertilised seedlings of the first generation would be used with all off-type palms rogued out as discovered.

FIBRES

Cotton

Gold Coast.—The Director of Agriculture, in a report covering the period January–June 1934, states that an unusually wet season, accompanied by destructive tornadoes, practically ruined the crop in southern Togoland and little progress could be made in that district. The farmers, however, are now convinced of the superiority of the Improved Ishan type introduced by the Department, and maintain their own seed supplies. Both in this district and in the Northern Territories, where the improved strain of Allen cotton known as D28 is maintained, the application of artificial manures has not proved economical, though giving small increases in yield. Prices are too low in the Northern Territories to induce farmers to take up the improved strain, which under good pure stand cultivation will yield from 250 to 300 lb. per acre.

Nigeria.—The following report by Mr. K. T. Hartley, Agricultural Chemist, Northern Provinces, covering the period January–June 1934, has been furnished by the Director of Agriculture.

Manuring Experiments.—Two experiments on the manuring of cotton were carried on during the season in continuation of experiments with guinea corn which have previously been reported. In one experiment farmyard manure was tested against a dressing of rotted grass, with and without the addition of mineral manures to bring the latter to the same nitrogen, potash and phosphate level as the farmyard manure. In the other case single and double dressings of farmyard manure were tested against equivalent dressings of artificials alone, and against a single dressing of farmyard manure plus a single dressing of artificials.

The manurial effect of rotted grass, as has been found before, was nil, but in both experiments the value of the artificial manures was considerably greater than has previously been observed with guinea corn. The results are quoted:

Experiment A		Experiment B	
Dressing	lb acre Seed cotton	Dressing	lb acre Seed-cotton.
No manure	135	No manure	169
2 tons per acre farmyard manure	306	1 ton per acre farmyard manure	248
Rotted grass equivalent to 2 tons farmyard manure	113	2 tons per acre farmyard manure	341
Do + N, P and K	453	Minerals equivalent to 1 ton farmyard manure	348
		1 ton per acre farmyard manure + equivalent minerals	363
		Minerals equivalent to 2 tons farmyard manure	427
Standard error	± 29	Standard error	± 26

Mr. J. K. Mayo, Agricultural Botanist, Northern Provinces, reports as follows:

Strain L, the Allen selection which is being multiplied up at present, did not do well in 1933. The season was unfavourable for cotton generally, but appears to have depressed L more than the ordinary variety, particularly where soil and rainfall conditions were markedly different from Zaria where the strain had been selected. In view of these results, distribution of L will be confined for the present to those districts which are similar in soil and rainfall conditions to Zaria.

In the report for January to June 1933 it was stated that selection work had been partially diverted towards improving yield, but with negative results (this BULLETIN, 1933, **31**, 420). Later selections, however, were tested in 1933–34 with more promising results, as shown in the table on page 460.

The lay-out was in the form of randomised blocks with ten repeats. Statistical analysis showed that D.31 gave a significantly larger yield of *seed-cotton* than A, G, B and F, and D.31 gave a significantly larger yield of *lint* than A, G, B, F and C.31.

F and G were two samples of the same thing—ordinary seed from the Zaria ginnery.

D.31 and C.31 were thought worth sending for a spinning test and broker's report. E.31 was excluded because of a great deal of " silvery lint " and immature seeds, characters which have come to be associated with " nep " and high percentages of dead hairs. The broker's report was unfavourable to the promising strain D.31, classing it as shorter and weaker than ordinary ginnery cotton (British Cotton Growing Association) and worth 6·66*d.* per lb. as compared with 7·01*d.*, with American futures at 6·26*d.* Actually strain D.31 is as yet far from pure, so that it still has possibilities.

Hybridisation has been continued, and 195 hybrid strains sent from Trinidad by the Empire Cotton Growing Corporation for observation at Zaria have just been planted. Some sixty of them have also been planted at Yandev in the Benue Province.

Selection work on the indigenous cotton at Yandev is progressing satisfactorily.

Mr. E. H. G. Smith, Botanical Section, Southern Provinces, has submitted the following report relating to his investigations on cotton.

Yield of Improved Ishan A Cotton on Moor Plantation.—Improved Ishan strain A cotton has now been grown on Moor Plantation over a period of six years, and the average yields are of interest. The following figures are included through the courtesy of the Superintendent of Agriculture :

Season	Approximate Acreage	Yield of Seed-cotton per Acre. *lb.*
1928–29	10	524
1929–30	77	545
1930–31	42	407
1931–32	22	378
1932–33	23	392
1933–34	20	299

Seasonal average, 424 lb. of seed-cotton per acre.

Yield Trial No.	1 Plot = $\frac{1}{75}$ Acre		Ginning Yield	Yield of Lint per Acre	Yield of Seed-cotton as percentage of Standard.[1]	Yield of Lint as percentage of Standard [1]	Lint Length	Seed Characters.				Immature Seeds.
	Average Stand (plants per plot).	Yield of Seed-cotton per Acre						Grey Fuzz	Green Fuzz	Naked.	Semi-naked.	
		lb	*Per cent*	*lb*			*mm*	*Per cent*	*Per cent*	*Per cent*	*Per cent.*	*Per cent.*
A	127·9	161	32·0	51·5	79	86·3	34·9	31	1	27	32	9
B	127	208	30·6	63·7	102	107	33·1	64	5	1	30	—
C	132·3	224	29·9	67	110	112	34·0	97	1	—	0·5	1·5
D	131·8	243	34·1	83	119	139	33·1	54·5	20	6	12	7·5
E	129·6	223	32·6	72·7	109	121·2	32·4	78	5	1	4	12
F (B.C.G.A.) . .	125	211	29·3	61·8	104	103·8	32·7	77	11	2	7	2·5
G (B C G.A.) . .	124	197		57·7	97	96·5	32·5					

[1] *The Standard basis of these figures is the mean of F and G.*

On the seed-cotton figures:

D was significantly better than A, G, B and F
B, F, E and C were better than A (signif.)

On the lint figures:

D was significantly better than A, G, B, F and C
E ,, ,, ,, ,, A and G.
C ,, ,, ,, ,, A.

The yield over the past season presents a very considerable drop on those recorded for previous years. But the average yield alone does not give quite a true picture, as a quarter of the acreage of 1933–34 happened to fall on distinctly poor land. Omitting the yield of this poor field, the average yield was 373 lb. per acre, a figure that more nearly approximates to the general average. The yields for the years 1928–30 were high, partly because much of this cotton was grown on virgin soil, and partly on account of a cycle of very favourable cotton seasons that then occurred, and the effect of these early seasons is to make the present general average artificially high. Nevertheless, with all these explanations, the yield over the past season was definitely below average. The crop at Moor Plantation suffered from the wet and sunless conditions that obtained early in the growing period, and at the end of the rains was backward and unpromising. Individual plants were small in size, thus yields were on the low side. The incidence of cotton pests and diseases was not judged to be abnormal, and these were not responsible for the poor yield. At Ibadan the cotton crop is largely influenced by weather conditions during the growing period, and adverse conditions, such as those which obtained in 1933, reduce the size of the plants and hence the yield.

Cotton Selection.—Cotton selection is now directed towards the maintenance of the purity and present standard of Improved Ishan strain A, while a search is made for an equally satisfactory Ishan cotton, but one having a smoother lint. Ishan A × Sea Island back-crosses are under study, and although they have not yet passed the preliminary stage, it may be noted that they provided the only exception to the poor individual yields of last season. Three other Ishan strains, selected after crossing on the lint character as superior in this respect to Ishan A, were under field trial for the first time. The results of this yield trial (included through the courtesy of the Superintendent of Agriculture) are as follows :

Average yield on 10 Control Plots of Ishan A, 239 lb per acre

	Odds that the Difference is Significant
Average difference Strain X – 67 ± 33 lb per acre .	. 43 : 1
” ” ” J – 16 ± 33 ” ” ” .	. < 3 : 1
” ” ” Q – 39 ± 33 ” ” ” .	. > 5 : 1

The results of the above test are somewhat inconclusive, but are not very favourable to these new strains. Strain J came out best on the figures, but other experience with this cotton has not suggested a high yielding capacity. It has been decided to defer further work with these cottons for the present, though very small plots of each will be retained, as observations suggest that none of them will ever be good enough to replace Ishan A. Extensive, and necessarily expensive, trials of new strains are not practical at the present time unless it is almost certain that such strains are likely to prove definitely superior to the standard cotton. This cannot be said for strains X, J and Q.

Silk

Gold Coast.—The Director of Agriculture, in a report covering the period January–June 1934, mentions that, with the assistance of the Advisory Committee of the Imperial Institute on Silk Production, the Eri silkworm, *Attacus ricini*, was introduced into the Colony from India and has now been successfully reared at Aburi. The " seed " cocoons of the moth were transported from Calcutta to England by air mail, and forwarded to Accra by sea in cool storage at a temperature of 46°–47° F., arriving in February 1934. The life cycle of the first generation, i.e. from egg to adult moth, was 34–46 days. The eggs hatch in 5–8 days, the larvæ grow and feed from 11–18 days, and the pupal stage is from 18–20 days. Stocks are being dispatched to other stations of the Department. There is no difficulty in growing the castor plant as food for the insect.

DRUGS

Kola

Nigeria.—The following report on work carried out by Mr. O. J. Voelcker, Botanical Section, Southern Provinces, has been furnished.

Investigations on the factors governing the incidence of white nuts in Gbanja kola have been undertaken during the past year. The white nut is more highly esteemed than the dark red—so much so that the price of the former is nearly double that of the latter. It is a well-known fact that trees planted from white nuts normally bear a large proportion of coloured nuts ; trees grown from coloured nuts—and these trees are numerous in Nigeria—appear to give only coloured nuts. Thus the bulk of the local-grown Nigerian nuts are of the less valuable red types.

It was mentioned in 1932 that there was a small isolated plot of Gbanja kola on Moor Plantation which had been grown from white nuts. These trees have given a high percentage of white nuts, thus :

	White.	Coloured
1931	485	183
1932	309	48
1933	309	33

To test the theory that these coloured nuts were the result of out-pollination by red trees, a number of self-pollinations were carried out. Pods resulting from these self-pollinated flowers yielded 582 white nuts and no coloured. Now if the flowers had not been self-pollinated there would have been an expectation of from 50 to 100 coloured nuts. There is thus an indication that if trees are planted from white nuts and out-pollination from trees grown from coloured nuts is guarded against, it will be possible to produce nothing but white nuts. Further studies by means of controlled pollination will be undertaken, and until these have been made, the incidence of coloured and white nuts in kola remains in the realms of theory.

The self-fertilised white seed mentioned above has been germinated, and it is proposed to establish isolated plots with the seedlings. In this respect the new cacao sub-stations at Owena and Odo Ona Nla—situated as they are in forest reserves and thus cut off from red kola grown on native farms—will be of great value as a site for these plots.

In the kola trade it is generally recognised that Sierra Leone kola fetches a better price than Nigerian kola. This is reflected in the abrupt drop of imported kola from the Gold Coast, where the kola appears similar to that grown in Nigeria, whereas the imports of Sierra Leone kola have remained large. Two factors are thought to account for the enhanced price of Sierra Leone kola: firstly, the superior keeping quality, and secondly, the higher proportion of pink or white nuts. It was thought desirable to establish plots of Sierra Leone kola in Nigeria, and seed from superior trees has been obtained through the courtesy of the Director of Agriculture of that Colony. This seed had been picked from three trees and was considerably larger than that obtained from the self-fertilised Moor Plantation flowers. Half of these Sierra Leone nuts were, however, dark red in colour, and only one-twelfth pure white.

FORESTRY

TIMBERS

Nigeria.—Mr. J. E. Taylor, Director of Forests, has furnished the following report on machining tests with various Nigerian timbers, carried out during the half-year ending June 30, 1934.

Pycnanthus Kombo

Moisture content.—Seventeen per cent. approximately.

Sawing.—A loose-grained wood, easy to rip-saw.

Strong tendency to tear when cutting across the grain, the fibre pulling out and leaving a rough woolly appearance.

Planing.—Planes easily to a smooth finish with no tendency to pick up. The open nature of the grain prevents a bright finish.

Spindle Moulder.—Machines well in the direction of the grain, but poorly on the end grain, leaving a very rough finish.

Mortising.—Does not stand up to a chisel mortising machine, the fibres turning from the tool and leaving a very ragged appearance. Better results were obtained on the chain mortiser, but not good.

Tenoning.—This machine gave better results, leaving a clean-cut shoulder. The same tendency for the grain to pull out was noticed.

Remarks.—The soft, woolly nature of this timber makes it difficult to machine across the grain. It has a peculiar mottled appearance which is probably largely due to staining.

Scottellia coriacea

Moisture content.—Seventeen per cent. approximately.

Sawing.—Saws easily without any apparent tendency to tear.

Planing.—Planes excellently to a smooth, clean finish, but with a rather dull appearance. There is a very occasional tendency to pick up when planing against the grain.

Spindle Moulder.—Gave good results both on the end-grain and with the grain.

Mortising.—Good, but rather disappointing. Did not give quite the clean finish previous tests promised.

Tenoning.—Very good, leaving a clean finish on tongue and shoulders.

Remarks.—A mild, easily worked timber, in general appearance, texture and working quality closely resembling American whitewood. It is unfortunately liable to blue stain.

Antiaris africana

Moisture content.—Fifteen per cent. approximately.

Sawing.—A soft wood which is easy to saw but has a strong tendency to tear.

Planing.—Does not plane well; grain is inclined to stare; and when planing against the grain, picks up very badly. The grain is often interlocking.

Spindle Moulder.—Gave bad results. Working across the grain the fibres tear out and leave a very rough finish. Even with the grain the finish was far from good.

Mortising.—Very rough. The fibres tear out, break and do not cut cleanly. The chain mortiser gave the better results.

Tenoning.—Fairly good.

Remarks.—The soft, loose nature of this timber makes it difficult to machine cleanly ; added to this, the uneven interlocking grain, which appears to be typical of the species, makes it impossible to obtain a smooth finish.

Guarea cedrata

Moisture content.—Seventeen per cent. approximately.

Sawing.—A nice mild timber which presents no difficulty in sawing.

Planing.—Patches of curly grain and distorted grain near knots, etc. ; has a tendency to pick up. On the whole the wood planes well to a good smooth finish.

Spindle Moulder.—Gives a good finish on all surfaces.

Mortising.—Mortises well with both chisel and chain types of tool. The walls of the mortise are left clean and smooth and there is no tearing.

Tenoning.—Gave excellent results and a cleanly cut finish.

Remarks.—Is recognised as an easily worked, high-quality timber.

Celtis sp.

Moisture content.—Sixteen per cent. approximately.

Sawing.—Saws easily and cleanly. There is a slight tendency to tear across the grain.

Planing.—Variable. When even, straight grain is present no difficulty is experienced, and a clean bright finish results. The grain is sometimes interlocking or distorted and then it picks up badly.

Spindle Moulder.—Gives a slightly rough finish across the grain but, on the whole, works well.

Mortising.—Variable. Sometimes the ends of the mortise are clean-cut and at others torn and rough. On the whole mortising was far from bad.

Tenoning.—Good, no tearing.

Remarks.—The nature of this timber seems to be rather variable, which may possibly be accounted for by the occurrence of very bad patches of blue staining.

Xylopia quintasii

Moisture content.—Sixteen per cent. approximately.

Sawing.—No difficulty was experienced in sawing this timber.

Planing.—Planes fairly well, giving a bright, lustrous finish. Close inspection shows that the grain is torn up here and there, without apparent reason, but this does not spoil the general effect, which is good.

Spindle Moulder.—A good finish is obtained with the grain, but rough across the end. The tissue surrounding the large pores does not cut cleanly, which results in a "goose flesh" appearance.

Mortising.—Good. The sides of the mortise are left reasonably clean with both types of tool.

Tenoning.—Good, no tearing.

Remarks.—Quite a nice timber and reasonably easy to work.

The following progress report by Mr. J. C. Mallam, Wood Seasoning Officer, on experiments relating to the kiln-seasoning of native timbers, has also been furnished by the Director of Forests.

Experiments Nos. K.7–K.12

The Killing of Borers in Seasoned Arere (Triplochiton scleroxylon)

In January 1934, six further kiln treatments were carried out with a view to destroying active borers (*Heterobostrychus brunneus* Murr) in Arere timber (*Triplochiton scleroxylon*). The main object in view was to ascertain the most economical method of killing this pest, which is capable of causing extensive damage in a very short time.

The following table summarises the results :

Experiment No	Date	Thickness of Timber	Dry Bulb Temperature	Wet Bulb Temperature	Relative Humidity	Time in Hours	Result
					Per cent		
K 7 .	5–6/1/34	1 in	60°	53°	70	19	All borers killed.
K 8 .	9/1/34	1 ,,	70°	59°	60	12	do.
K 9 .	12–13/1/34	1 ,,	70°	59°	60	15¾	do.
K 10 .	16/1/34	1 ,,	70°	59°	60	12½	do.
K 11 .	19/1/34	1 ,,	70°	59°	60	12½	do
K 12 .	22/1/34	1 ,,	70°	59°	60	12½	do.

It will be observed that the same treatment was employed in all the last five experiments, there being a slight variation in time only in the cases of K.8 and K.9. While, it is true, each treatment proved successful, it was thought inadvisable to reduce the severity or length of treatment for fear of failure in attaining the ultimate object—that of killing the borer. This borer is such a serious pest that no risk of spreading infection can reasonably be taken, even for an experimental purpose.

The average cost per treatment was :

	£	s.	d.
Labour loading and unloading	1	3	2
Labour seasoning		5	4
Electricity (89 units)	1	0	4
	£2	8	10

Approximate cost per cubic foot = 1·2*d.*

It was not possible to continue the experiments owing to lack of material, as the borer has been almost completely eradicated from the sawmill. Mr. Mallam points out, however, that should another epidemic occur, it would be as well to insert a considerable number of infected sample boards in the kiln load. At intervals of say one hour, a sample could be withdrawn and investigations made to find out at what point the borer is effectively destroyed. A margin of safety would, of course, be allowed when finally recommending a treatment.

MINERAL RESOURCES

CYPRUS

The Imperial Institute has received from the Colonial Secretary the following statement in regard to the mining operations carried out in Cyprus during the six months ended June 30, 1934.

Unsettled conditions on the Continent, to which the bulk of the ore is sent, have been responsible for the decrease in the export of pyrites.

A concession on the part of Government, in the matter of a temporary reduction of royalty rates, has enabled the Asbestos Company successfully to enter new markets, with the consequent appreciable increase in the production of asbestos and in the number of persons employed at Amiandos.

Work done by the Cyprus Mines Corporation at the Skouriotissa Pyrites Mine

	First 6 Months 1934	First 6 Months 1933.
Underground development, footage.	1,276	3,887
Tonnage mined	68,787	108,745
Underground labour (average per day)	829	618
Tonnage exported	61,713	101,180
Labour, surface and underground (average per day)	1,465	1,308

Work carried out at the Mavrovouni Pyrites Mine, by the Cyprus Mines Corporation

	First 6 Months 1934	First 6 Months 1933
Underground development, footage	7,354	nil
Tonnage mined	33,129	119
Underground labour (average per day)	235	11
Tonnage exported	26,450	6,071
Labour, surface and underground (average per day)	1,000	85

Work done at the Lymni Mine of the Cyprus Sulphur and Copper Co, Ltd.

	First 6 Months 1934	First 6 Months 1933
Underground development, footage	nil	nil
Opencast, overburden removed, cubic yds	nil	nil
Tonnage mined	nil	nil
Copper precipitate produced, tons	nil	3
Labour (average per day)	2	3

Work done at the Troodos Mines of the Cyprus Chrome Co, Ltd

(Mining Lease and Prospecting Permits areas)

	First 6 Months 1934	First 6 Months 1933
Development, total footage	220	280
Tonnage mined	120	nil
Tonnage exported	—	nil
Labour (average per day for 3 months)	50	48

Work done by the Cyprus Mines Corporation, Skouriotissa, in the production of "Devil's Mud" (auriferous andesite)

	First 6 Months 1934	First 6 Months 1933
Underground development, footage	11,465	3,561
Tonnage mined	3,924	307

Work done by the Cyprus and General Asbestos Co, Ltd, Amiandos

(Formerly Cyprus Asbestos Co, Ltd)

	First 6 Months 1934	First 6 Months 1933
Rock mined, tons	407,795	116,176
Rock treated, tons	85,320	23,826
Finished asbestos produced, tons	2,743	1,217
Finished asbestos exported, tons	3,334	1,158
Average daily labour (quarries only)	732	185
Average daily labour (all operations)	1,193	377

Work done by the Hellenic Company of Chemical Products and Manures, Ltd.

(Lease on Troodos)

	First 6 Months 1934.	First 6 Months 1933
Rock mined, tons	nil.	—
Rock treated, tons	nil	—
Finished asbestos produced, tons	nil	—
Finished asbestos exported, tons	nil	—
Average daily labour (quarries only)	nil	—
Average daily labour (all operations)	7	—

Minerals exported other than those dealt with above were as follows:

	First 6 Months 1934	First 6 Months 1933
Gypsum, calcined, tons	4,736	5,625
Gypsum, raw, tons	1,128	949
Stone, building, cubic yds	73	73
Stone, pumice, tons	322	nil
Terra umbra, tons	2,411	1,627
Terra verte, tons	19	nil.

FEDERATED MALAY STATES

The Imperial Institute has received the following statement from the Director regarding the work carried out by the Geological Survey during the six months ended June 30, 1934.

The Director has been occupied on field work in Pahang, making a geological survey of districts in which gold occurrences are known, including Silensing and Buffalo Reef and Kuala Lipis. Additional evidence was collected from the Raub District.

The Mining Geologist has continued with the preparation of the record of prospecting results, and has done field work in the Batang Padang district of Perak.

Various reports on mining properties have been supplied, and the usual help has been given in the identification of minerals and rocks. Chemical work on metals, minerals and oils has continued.

GOLD COAST

The Imperial Institute has received the following statement from the Director of the Geological Survey, of the work carried out by the department during the six months ended June 30, 1934.

The survey of the gold resources of the Colony and Ashanti was continued and almost completed as far north as lat. 7° 30′ N. During the course of this work, several areas not previously examined by the department were geologically mapped and prospected.

Numerous unworked gold prospects, several of which are worthy of more detailed investigation, were located and a new auriferous reef containing values sufficiently encouraging to justify further work on it was discovered near Kukuom. Details of these occurrences are being published in the Annual Report of the Geological Survey for 1933–34.

Several deposits of manganese ore in the district north and north-east of Sekondi were examined. None of the occurrences is of commercial importance.

Deposits of bauxite occur in the hills near the frontier west-north-west of Sunyani. The deposits are not comparable in size or quality with those of Sefwi and Yenahin, and they are too remote to be of economic importance.

A revised geological map of the southern section of the Gold Coast, on which is shown the positions of the gold mines and most of the known gold prospects, has been prepared and will be published before the end of the year.

Memoir No. 3, *The Geology of the Prestea Goldfield*, has now been published.

NIGERIA

The Imperial Institute has received the following statement from the Director regarding the work carried out by the Geological Survey during the six months ended June 30, 1934.

Gold.—During the latter part of the half-year under review geological work has been carried out in the valley of the Zamfara River in the southern part of Sokoto Province, where there is at present considerable mining activity. This lies to the north of the areas previously examined and the investigation is of a preliminary nature only. The rocks consist chiefly of gneisses with scattered blocks of schists, and it is on these blocks that mining operations are more particularly concentrated.

The gold is mainly alluvial and as a rule operations are confined to the actual stream beds. Well-developed terrace deposits line the banks of many of the streams, but these have not been exploited to any extent as yet. An interesting and important feature, however, is the discovery of auriferous terrestrial deposits apparently unrelated to the present drainage system. Along some of the rivers these deposits are extensive and are contributing a not inconsiderable proportion of the gold won in certain districts. Quartz reefs, veins and stringers ramify through the whole of the schist areas, and these, no doubt, constitute the original source of the gold. The prospecting of reefs has not yet been undertaken seriously, but in a few cases the values obtained have been sufficiently promising to justify further work and expenditure. The production of gold for the half-year is 17,632 oz.

Diamonds.—Within the last few weeks, two diamonds have been found in the course of alluvial gold mining. The first, a small stone of about half a carat, came from near Birnin Gwari in the Zaria Province ; the second, of over ten carats, was taken from the Sokoto River in the Sokoto Province. Certain preliminary investigations regarding the occurrence of these diamonds have already been undertaken and will, it is expected, be continued in the next field season.

Water Supplies.—In the Northern Provinces, shaft-sinking operations have been continued in the Emirates of Sokoto, Katsina, Daura, Gumel and Bornu and lately commenced in the Babura district of Kano Emirate. Results have been eminently satisfactory and 103 shafts have been brought into production for the half-year for a total footage of 6,450 sunk. In all areas where it has been found possible to control the flow of ground-water, pressure rises are being obtained.

The south-western part of Gumel has been completed and the crews are now concentrated in the north-west of the Emirate. Eighteen new shafts have been sunk to water at an average depth of 158 ft. The cost is 7*s*. 3*d*. per foot completed. Sub-artesian rises ranging from 13 ft. to 42 ft. have been obtained in twelve of these wells, all of which are in sediments belonging to the Chad group. Since this work commenced a considerable influx of new settlers has been reported.

In the adjoining Daura Emirate, successful results have been obtained, although in most cases the volume of ground-water has made deeper sinkings impossible. During this period sixteen wells have been sunk to water.

In Bornu, the policy of opening up the country adjoining the main Balle-Maiduguri road, which is traversed by many important trade routes, has been continued. In this area the water is deep-seated and the presence of both loose sands and tough clays has doomed to failure wells sunk by native methods. Pressure rises are frequently encountered, the greatest measuring 63 ft. During the period under review fifteen wells have been completed at an average cost of 7·90*s*. per foot.

In the Katsina Emirate a certain amount of water-supply work has been undertaken in connection with the work of the Forestry Department. Nineteen wells have been brought into production in the half-year at a cost of 8*s*. 6*d*. per foot. In Sokoto Emirate, a start has been made with the development of the sparsely inhabited Tangaza District in the north-west corner of the Protectorate. A considerable influx of immigrants is anticipated.

Geophysical prospecting for water has been continued in the Owerri and Aba Divisions in the Southern Provinces.

TANGANYIKA TERRITORY

The Imperial Institute has received the following report from the Director of the Geological Survey regarding the work carried out by his department during the year ended June 30, 1934.

The work was entirely of an economic nature and may be dealt with under four heads : (1) the geological investigation of the gold resources of the country ; (2) the provision of supplies of deep-seated water by boring ; (3) the maintenance of the service afforded by the chemical and petrographical laboratory and assay office ; (4) the maintenance of the drawing office service for the supply of sun-print maps.

1. *Gold.*—On account of the gold premium and the consequent importance assumed by gold among the exports from the Territory, a gold-mining industry committee was formed to promote useful co-operation between the heads of those Government departments concerned with survey, transport, mining and geological questions. This arrangement proved highly successful and, so far as the Geological Survey Department was concerned, resulted in a record output of work, despite the depleted condition of its staff following recent retrenchment.

Some justification for the attention paid to gold during the year to the exclusion of other minerals is lent by the following production figures of the Territory, which speak for themselves :

Year	Gold Production		Other Minerals Value £ sterling
	Oz	Value £ sterling	
1931	15,200	58,449	55,321
1932 . .	30,881	149,864	48,833
1933 . .	39 533	201,886	52 607
1934 (first 5 months)	24,559	132,678	19,678

By co-operation with the Survey Department implemented by the means already referred to, it was found possible to place no fewer than five parties in the field concurrently for the detailed investigation of known auriferous areas. The production of reliable maps showing the geology of these areas was deemed to be of primary importance as affording the needed assistance to the gold-mining interests of the Territory, and for this reason no rapid mineral reconnaissance of a general nature was undertaken.

Three of the above-mentioned parties, two of which were geological and one topographical, were occupied in mapping the eastern extension of the Lupa Goldfield. An area of 540 square miles of difficult terrain was topographically surveyed on a scale of 1 : 100,000, 374 square miles of which were geologically mapped ; and in addition to this a plan was prepared showing all reef occurrences and corresponding assay values at surface. The Director gave this work his personal supervision, and it was proved that the area possessed similar geological features to those of the western area with equal promise in regard to the finding of payable auriferous reefs. The marked association of diorite and granite (Chunya type) is comparable with that of the diorite and granite (Saza type) of the western area, and the relation of alluvial deposits and auriferous quartz reefs to this suite of rocks is most striking. The dominant rock, as elsewhere in the field, is the granitic gneiss with smaller areas of a gneissose microcline-granite and of banded ironstone.

Most of the gold at present being won on the Lupa is of alluvial or eluvial origin. There are no extensive and well-distributed placers, except perhaps in the Sira Valley, where conditions, owing to overlying lake beds and to a very irregular floor of bed-rock, add special difficulties to the recovery of the gold, and elsewhere the precious metal is of extremely sporadic distribution. Mineralised quartz reefs are extremely numerous and vary very much in size. Many of them show good prospects, and with the large-scale development now in progress it is certain that before long the output of reef gold from this field will equal if not surpass the alluvial production.

The remaining two parties operated in the northern gold-belt, 1,850 square miles being topographically and geologically mapped, mostly on a scale of 1 :250,000, in the south-western Mwanza District ; and 2,070 square miles on a scale of 1 : 100,000 in the Musoma District. In the latter region great assistance was rendered by the Survey Department in preparing the topographical basis for depicting the geology, and fifty-four square miles of mine properties on a scale of 1 : 25,000 were mapped in addition.

The northern goldfields already have many small mills operating, but no alluvial gold is produced. As regards the south-western Mwanza area, it has now been shown that the gold occurs in normal quartz reefs or as impregnations in rocks of the Upper Basement Complex (Archæan) occurring as roof-pendants in a granite batholith. These ancient rocks comprise both acid and basic lavas and their associated pyroclastic derivatives and are more or less covered by the field terms " porphyry," " banded ironstone " and " greenstone." The affinities of these rocks are at present far from clear, and the relation of certain of the porphyritic rocks and of the banded ironstones to the volcanic rocks has yet to be proved.

In the Musoma area the gold occurs in much the same way as that just described though the lithology is much more varied. The most important series consists of acid and basic lavas with their derivatives, including banded ironstones (Musoma Series) associated with dacite-porphyry and quartz porphyry (Kuria Volcanics), the whole being equivalent to the Upper Basement Complex. Overlying this is a series of metamorphosed sediments (North Mara Series) consisting of conglomerates, felsitic grits, quartzites and phyllitic shales, having an average dip of about 55°, believed to correspond with the Muva-Ankolean of Central Africa. Not showing direct relationship with the last, but clearly younger, is a series of unfossiliferous sandstones, shales and quartzites. These, from their flat-bedded nature and lithological similarity, are correlated with the Bukoba and Buanji Series of Tanganyika (Waterberg of South Africa), and are known as the Ikorongo Series. The youngest rocks are phonolitic lavas of Tertiary age forming a continuous capping in places. The older rocks are also masked by extensive unconsolidated formations, mainly of an eluvial origin, so that the geological maps produced will clearly be of great assistance in indicating unproductive areas. Of the major intrusives the most important is a younger-type granite comparable with that occurring in the south-western Mwanza District, which invades all formations older than the Ikorongo Series ; but of special interest is an older but non-foliated granite which from unequivocal field evidence is clearly pre-North Mara and post-Musoma, i.e. of greater age than the Muva-Ankolean. The main period of gold mineralisation is believed to have occurred following the intrusion of the younger granite, which was the means of introducing the gold-bearing solutions with formation of veins of auriferous quartz and impregnations of pyrite in shattered zones of the intruded rocks. Dyke-rocks are exceedingly numerous, comprising ancient epidiorites, acid, intermediate and basic offshoots of the granite, including an interesting series of lamprophyres, and post-mineralisation dolerites.

The similarity of the Mwanza and Musoma gold occurrences to those of Kenya and Southern Rhodesia is worthy of note.

The number of auriferous areas recorded in the Territory continues steadily to increase, and, among those discovered through the enterprise of prospectors, that on the eastern edge of the Iramba Plateau near Singida would seem to offer the most promise.

2. *Water Supplies.*—As regards water supply, a full drilling programme was maintained throughout the year, mainly for the benefit of sisal plantations. The most

striking results were obtained in the coastal sediments of the Tanga and Pangani Districts, but good supplies were also tapped from the crystalline rocks farther inland. The following statistical figures relating to the calendar year 1933 will be of interest in this connection.

The total footage drilled was 3,608 ft., of which 36 per cent. was in hard crystalline rock, and the number of boreholes put down by the two Star plants operating was fifteen. This resulted in a total of 598,200 gallons of potable water per 24-hour day being added to the resources of the Territory. This footage includes a bore of 56 ft. put down in the neighbourhood of a brine spring at Uvinza which was successful in largely increasing the supply. The proportion of successful boreholes (54 per cent.) may not appear large and it should be stated that in several instances operations were stopped by the hirer, contrary to the wishes of the department, far short of the depth at which hopes of striking a supply of water might reasonably be entertained.

3. *Laboratory.*—The laboratory is equipped for identification of rocks and mineral substances ; for the performance of fire-assays for precious metals ; wet assays of metallic ores ; and chemical examination of waters, brines, clays, limestones, natural salts and fuels, and fertilisers as well as other miscellaneous materials. The service is being made use of to an ever-increasing extent and was fully maintained throughout the period under review.

4. *Maps.*—Work in the drawing office included the preparation of the numerous geological maps and diagrams accompanying the reports on the three gold areas referred to above, which it is hoped will be ready for sale towards the end of this year or early in 1935. In addition to this a record number of sun-prints embodying advance information have been sold to members of the mining community.

The well-boring, laboratory and drawing-office services are all revenue-earning, the sum earned during the calendar year of 1933 being the highest on record, viz. about £2,300.

UGANDA

The Imperial Institute has received from the Acting Director the following report on the work carried out by the Geological Survey during the six months ended June 30, 1934.

During the period the Director, besides other journeys of inspection, paid several visits to mining claims in Ankole and Kigezi, and some of the interesting gold occurrences, while many of the newly discovered tinstone deposits were also examined. Of particular interest is the occurrence in Ankole of crystalline gold in a stream bed. This gold is little worn, obviously not far from its source, and some advice was given on the probable source of it. Specimens of this gold were presented to the Geological Survey collection, and some crystals were sent to the British Museum. They are in octahedral forms and the largest received has faces about 1 cm. long, but the crystals usually show unequal development in flattened triangular and hexagonal shapes.

The ascertained exports of fine gold for the period January to the end of May were 3,776 troy ounces valued at £25,697.

From Ankole, near the Kigezi border, numerous beautiful samples of cassiterite have been received, which show crystal faces and are from hill detritus, but are only slightly eroded and have not come far from the parent veins. The crystals are usually prismatic, with the usual sets of pyramid faces, and another interesting occurrence is in Kigezi, where the tinstone crystals show strong development of the pyramid faces and present quite a different appearance. There is no doubt that the active prospecting which has taken place lately has led to the location of occurrences of cassiterite that bid fair to be of importance.

With the cassiterite, in some few places, there occurs also tantalite, of about the same specific gravity, that is difficult to separate and for which there appears to be only a small market at present. It is perhaps fortunate that this unwanted mixture is not common and that Uganda tinstone usually occurs in mica and quartz veins with no other heavy minerals, and is therefore easily separated and concentrated to over 70 per cent. metallic tin content.

Mr. Wayland went on leave early in June and Mr. Combe early in March, so that again the activities of this Survey are somewhat curtailed. Dr. Davies has spent two months in Karamoja advising on water supply and on road sites, and later moved to an area north of Mount Elgon to continue his investigations of that district.

In the laboratory there has been an increased amount of work for prospectors.

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Proceedings of the First and Second Meetings of the Fertilizers Sub-Committee of the Nyasaland Tobacco Association held on April 19 and 26, 1933 *Bull No* 7 (*New Series*), *Dept. Agric , Nyasaland.* (Zomba Government Printer, 1933)

The Nitrogen Nutrition of Tobacco By W W Garner, C W. Bacon, J D Bowling and D E Brown *Tech Bull No* 414, *U S Dept Agric* Pp 77, 9 × 6 (Washington Superintendent of Documents, Government Printing Office, 1934) Price 10 cents

Bemesting van Tabak met Crotalaria By D Tollenaar. *Med. No* 80, *Proefsta v Vorstenlandsche Tabak* Pp 43, 10¾ × 7¾ (Java . Proefstation voor Tabak, 1934) With Summary in English. Deals with the green manuring of tobacco with Crotalaria.

Diseases of Tobacco in Malaya By A Thompson *Malayan Agric. Journ* (1934, **22**, 263–269)

Bestrijding der Krul- en Kroepock-Ziekten van Tabak. By T. H. Thung. *Med. No.* 78, *Proefsta. Vorstenlandsche Tabak.* Pp. 17, 10¾ × 7¾. (Java: Proefstation voor Vorstenlandsche Tabak, 1934.) With English Summary. Deals with the control of curl and crinkle diseases of tobacco.

Onderzoekingen over Brandbaarheid van Tabak. II. By C. Coolhaas. *Med. No.* 79, *Proefsta. Vorstenlandsche Tabak.* Pp. 104, 10¾ × 7¾. (Java: Proefstation voor Vorstenlandsche Tabak, 1934.) With English Summary. An account of investigations on fire-holding capacity of tobacco leaf.

Drugs

Der Anbau Aromatischer Heilpflanzen Europas in Wärmeren Ländern. By W. Himmelbaur. *Tropenpflanzer* (1934, **37**, 203–207). Deals with the cultivation of European aromatic drug plants in the tropics.

Report on the Operation of the Opium Department, India, for the year ending September 30, 1933. Pp. 18, 9¾ × 6½. (Delhi: Manager of Publications, 1934.) Price Annas 12 or 1*s.* 3*d.*

Dyestuffs

La Henna. By A. M. Morgantini. *Boll. del Ro. Uff. Serv. Agrari, Tripolitania* (1934, **8**, 131–140). An account of the cultivation, harvesting and marketing of henna in Tripoli.

Saffron in Kashmir and its Cultivation. By M. R. Fotidar. *Agriculture and Livestock in India* (1934, **4**, 242–247).

Miscellaneous Agricultural Products

Experiments with Bagasse Carbon. By J. F. Williams. *Trop. Agric., W.I.* (1934, **11**, 107–110).

Utilisation of Non-Edible Seeds and Seed-Cakes. I. Vegetable Casein from *Pongamia glabra* and its Applications. By N. Srinivasan and V. Subrahmanyan. *Journ. Ind. Inst. Sci.* (1934, Vol. 17A, Part V, 49–74).

Gluconic Acid. Production by Submerged Mold Growths under Increased Air Pressure. By O. E. May, H. T. Herrick, A. J. Moyer and P. A. Wells. *Indust. Eng. Chem.* (1924, **26**, 575–578).

Hops. Report of the Provisional Committee Appointed by the Minister of Agriculture and Fisheries. Pp. 16, 9¾ × 6. (London: H.M. Stationery Office, 1934.) Price 3*d.*

The Downy Mildew of the Hop in 1933. By E. S. Salmon and W. M. Ware. *Journ. S.E. Agric. Coll., Wye, Kent* (1934, No. 34, 107–113).

Livestock and Animal Products

Conference on Co-ordination of Veterinary Research held at Kabete, Kenya, January 6 to 10, 1934. Pp. 80, 9¾ × 6. (Nairobi: Government Printer, 1934.)

Livestock Diseases Report No. 9, Department of Agriculture, New South Wales, recording Control Work during the year ended June 30, 1933. Pp. 17, 9½ × 6. (Sydney: Government Printer, 1934.)

Cattle and Beef Survey. A Summary of Production and Trade in British Empire and Foreign Countries. *Imperial Economic Committee Survey No.* 1. Pp. 367, 9¾ × 7¼. (London: H.M. Stationery Office, 1934.) Price 5*s.*

Ox Warble Flies. By R. Stewart MacDougall. *Trans. Highland and Agric. Soc., Scotland* (1934, **46**, 1–90). An account of this pest of cattle and its control, particularly with derris preparations.

The Ox Warble Fly. By S. K. Sen. *Agriculture and Livestock in India* (1934, **4**, 189–196).

The Export of Chilled Beef—The Preparation of the "Idomeneus" Shipment at the Brisbane Abattoir. By W. A. Empey, W. J. Scott and J. R. Vickery. *Journ. Counc. Sci. Indust. Res., Australia* (1934, **7**, 73–77).

Feeding, Care and Management of Young Dairy Stock. By J. B. Shepherd and F. W. Miller. *Farmers' Bull. No.* 1723, *U.S. Dept. Agric.* Pp. 32, 9 × 6. (Washington, D.C.: Superintendent of Documents, Government Printing Office, 1934.) Price 5 cents.

Some Sheep Feeding Experiments. By W. G. R. Paterson. *Trans. Highland and Agric. Soc., Scotland* (1934, **46**, 146–169).

Raising Fat Lambs on Subterranean Clover Pasture Lands. By L. J. Cook. *Journ. Dept. Agric., S. Australia* (1934, **37**, 1232–1241).

Parasitic Worms and their Importance in Sheep-farming. By J. B. Orr, A. H. H. Fraser and D. Robertson. *Trans. Highland and Agric. Soc., Scotland* (1934, **46**, 113–125).

Sheep Maggot Flies in Scotland. By J. Ritchie. *Scottish Journ. Agric.* (1934, **17**, 249–260). Includes methods of control and cost of treatment.

The Production of Bacon Pigs. By A. Calder. *Trans. Highland and Agric. Soc., Scotland* (1934, **46**, 224–242).

Export of Frozen Porkers to the United Kingdom. By A. E. Romyn and C. A. Murray. *Rhodesia Agric. Journ.* (1934, **31**, 300–337). An account of an experimental shipment and reports on quality.

A Comparison of Some Vitamin A Supplements for Chick Feeding. By M. W. Miller and G. E. Bearse. *Bull. No.* 292, *Washington Agric. Exper. Sta.* Pp. 19, 9 × 6. (Pullman: State College, 1934.)

The Co-operative Marketing of Eggs in Malaya. By J. G. Crawford. *Malayan Agric. Journ.* (1934, **22**, 183–185).

Rex-furred Rabbits. By W. King Wilson. *Bull. No.* 73, *Min. Agric. and Fisheries.* Pp. 13, 9½ × 6¼. (London: H.M. Stationery Office, 1934.) Price 1*s.*

Fifty-second Annual Report of the Fishery Board for Scotland, being for the year 1933. Pp. 92, 9½ × 6. (Edinburgh: H.M. Stationery Office, 1934.) Price 1*s.* 6*d.*

Recent Progress in Leather Manufacturing Methods, with a Note as to Future Requirements. By M. C. Lamb. *Leather World* (1934, **26**, 701–703).

Insect Pests in the Leather Industry. By E. C. Line. *Journ. Intern. Soc. Leather Trades' Chemists* (1934, **18**, 244–258).

FORESTRY

General

Fourteenth Annual Report of the Forestry Commissioners for the year ending September 30, 1933. Pp. 41, 9½ × 6. (London: H.M. Stationery Office, 1934.) Price 9*d.*

Report of the Director of Forestry, Department of the Interior, Canada, 1932–33. Pp. 23, 9¾ × 6½. (Ottawa: King's Printer, 1934.)

The Forests of Manitoba. By J. D. B. Harrison. *Forest Service Bull.* 85, *Dept. Inter., Canada.* Pp. 80, 9¾ × 6½. (Ottawa: King's Printer, 1934.)

Administration Report of the Acting Conservator of Forests, Ceylon, for 1933. Pp. 16, 9¾ × 6¼. (Colombo: Government Record Office, 1934.) Price 20 cents.

Report of the Forest Administration in Cyprus for the year 1933. Pp. 47, 9 × 6. (Nicosia: Conservator of Forests, 1934.) Price 1*s.*

Report of the Forest Trust, British Honduras, for the annual period ending March 31, 1933. Pp. 22, 13 × 8½. (Belize: Government Printers, 1934.)

Annual Progress Report on Forest Administration in the Presidency of Bengal for the year 1932–33. Pp. 113, 9¾ × 6½. (Alipore: Superintendent, Government Printing, 1934.) Price Rs. 1–9 or 2*s.* 8*d.*

Report of Forest Administration, Federated Malay States, for the year 1933. Pp. 89, 9½ × 6. (Kuala Lumpur: Government Printer, 1934.)

Annual Report of the Forestry Department, Nyasaland, for the year ended December 31, 1933. Pp. 19, 13 × 8½. (Zomba: Government Printer, 1934.) Price 1*s.*

Annual Report of the Director of Forestry, Philippine Islands, for the fiscal year ended December 31, 1932. Pp. 340, 9 × 6. (Manila: Bureau of Printing, 1933.)

Annual Report of the Forest Department, Sarawak, for the year 1933. Pp. 8, 13¾ × 8¾. (Kuching: Government Printer, 1934.)

Annual Report of the Forest Department, Sierra Leone, for the year 1933. Pp. 8, 13 × 8. (Freetown: Government Printer, 1934.) Price 2*s.* 6*d.*

Administration Report of the Conservator, Forest Department, Trinidad and Tobago, 1933. Pp. 22, 13 × 8½. (Port-of-Spain: Government Printing Office, 1934.) Price 10*d.*

Annual Report of the Forest Department, Uganda, for the year ended December 31, 1933. Pp. 23, 13½ × 8½. (Entebbe: Government Printer, 1934.) Price Sh. 1/50.

Remarques à propos de la Forêt Équatoriale Congolaise. By É. de Wildeman. Pp. 120, 10 × 6½. (Bruxelles: Institut Royal Colonial Belge, 1934.)

Some Notes on Tree-Planting with special Reference to Natal. By N. L. King. *Bull. No.* 29, *For. Dept., Union of S. Africa.* Pp. 57, 9½ × 6. (Pretoria: Government Printer, 1934.) Price 6*d.*

Growth and Injurious Effects of *Cronartium ribicola* Cankers on *Pinus monticola.* By H. G. Lachmund. *Journ. Agric. Res.* (1934, **48,** 475–503).

Le Liège. *Rev. Intern. des Prod. Coloniaux* (1934, **9,** No. 101, 161–188; No. 102, 223–234). A series of articles dealing with the cork-oak industry in Algeria, its cultivation in Italy and Russia, and the trade in cork in various European countries and the United States.

Timbers

Collapse and the Reconditioning of Collapsed Timber. *Trade Circ. No.* 20, *Counc. Sci. Indust. Res., Div. For. Prod., Australia.* Pp. 22, 9½ × 6. (Melbourne: Government Printer, 1934.)

The Treatment of Timber for Butter Boxes. By W. Riddet, G. M. Valentine and F. H. McDowall. *New Zealand Journ. Sci. and Tech.* (1934, **15,** 309–317).

Drying Rooms for Furniture Stock. *Trade Circ. No.* 21, *Counc. Sci. Indust. Res., Div. For. Prod., Australia.* Pp. 10, 9½ × 6. (Melbourne: Government Printer, 1934.)

Kiln-Drying British Columbia Lumber. By J. H. Jenkins. *Bull.* 86, *Forest Serv., Dept. Interior, Canada.* Pp. 78, 9¾ × 6½. (Ottawa: King's Printer, 1934.)

Notes on Malayan Timbers. By H. E. Desch. *Malayan Forester* (1934, **3,** 90–102). Deals with Merbau (*Afzelia* spp.), Kempas (*Koompassia malaccensis*), Tualang (*Koompassia excelsa*) and Keranji (*Dialium* spp.)

Chankol Handles. By B. S. Mee. *Malayan Forester* (1934, **3,** 75–80). Tests with various Malayan timbers as handles for the " Changkol," a large kind of hoe.

Durability Tests on Untreated Indian Timbers at Dehra Dun. Results of Latest Inspection, November 1933. *Indian Forester* (1934, **60**, 337–341). Deals with tests against white ant and fungus attack.

Note sur Quelques Bois du Gabon. By D. Normand. *Rev. Bot. Appl. et d'Agric. Trop.* (1934, **14**, No. 154, 414–421). Notes on the timbers Izombé (*Testulea gabonensis*), Bubinga (*Copaifera Demeusei*), Kevazingo (*Copaifera Tessmannii*).

L'Angélique et ses Usages. By M. Demougeot. *Rev. Intern. des Prod. Colon.* (1934, **9**, 209–215).

Methods for the Identification of the Light-coloured Woods of the Genus Eucalyptus. By H. E. Dadswell, M. Burnell and A. M. Eckersley. *Bull. No.* 78, *Counc. Sci. Indust. Res., Australia.* Pp. 60 + 35 plates, 9½ × 6. (Melbourne: Government Printer, 1934.)

Some Mechanical Properties of Alpine Ash (*Eucalyptus delegatensis* R.T.B.). By M. B. Welch. *Journ. and Proc. Roy. Soc., N.S. Wales* (1933, **47**, 385–402).

Properties of White Fir and their Relation to the Manufacture and Uses of the Wood. By R. P. A. Johnson and M. R. Brundage. *Tech. Bull. No.* 408, *U.S. Dept. Agric.* Pp. 76, 9 × 6. (Washington, D.C.: Superintendent of Documents, Government Printing Office, 1934.) Price 10 cents.

Le Difou (*Morus mesozygia* Stapf) By A. Aubréville and D. Normand. *Rev. Bot. Appl. et d'Agric. Trop.* (1934, **14**, No. 152, 251–256). An account of the tree and its wood.

Open-Tank Treatment of Red Pine Lumber. By J. F. Harkom. *Circ. No.* 40, *Forest Serv., Dept. Inter., Canada.* Pp. 16, 9¾ × 6½. (Ottawa: King's Printer, 1934.)

Chemical Studies of Wood Preservation. By R. R. Williams, R. E. Waterman, C. O. Wells and R. L. Peek. *Indust. Eng. Chem., Anal. Ed.* (1934, **6**, 308–314).

Gums and Resins

New Uses of Naval Stores Products. By O. A. Pickett and J. M. Schantz. *Indust. Eng. Chem.* (1934, **26**, 707–710). Deals with new uses of rosin, pine oil and turpentine.

Turpentine and Rosin from Wood Wastes by the Steam and Solvent Process. By R. C. Palmer. *Indust. Eng. Chem.* (1934, **26**, 703–706).

Rosin Derivatives in Paint Products. By J. McE. Sanderson. *Indust. Eng. Chem.* (1934, **26**, 711–715).

Use of Rosin for Soap Manufacture. By A. Campbell. *Indust. Eng. Chem.* (1934, **26**, 718–719).

Brazilian Copaiba Balsam. By F. W. Freise. *Perf. and Ess. Oil Rec.* (1934, **25**, 218–219). Notes on various species of *Copaifera* and the balsams yielded.

Tanning Materials

Over Mangrove Culturen. By B. de Jong. *Tectona* (1934, **27**, 288–303).

Annual Report of the Committee of the Wattle and Timber Growers' Association, South Africa, June 1933 to June 1934. Pp. 5, 13¼ × 8¼. (Pietermaritzburg: Wattle and Timber Growers' Association, 1934.)

Points on Wattle Production. By I. J. Craib. *Bull. No.* 28, *Forestry Dept., Union of S. Africa.* Pp. 9, 9½ × 6. (Pretoria: Government Printer, 1934.)

The Present Position in the Wattle Industry. *Mimeographed Report issued by the Wattle and Timber Growers' Association, Union of South Africa.* Pp. 5, 13 × 8. (Pietermaritzburg: Wattle and Timber Growers' Association, 1934.)

NOTICES OF RECENT LITERATURE

Books for review should be addressed to " The Editor," Bulletin of the Imperial Institute, South Kensington, London, S.W.7.

The Handbook of Palestine and Trans-Jordan. Edited by Sir Harry Luke, C.M.G., B.Litt., M.A., and Edward Keith-Roach, O.B.E. Third Edition. Pp. xvi + 549, 7½ × 5. (London : Macmillan & Co., Limited, 1934.) Price 16*s.*

The first edition of this work, under the title *The Handbook of Palestine,* appeared in 1922, and was reviewed in this Bulletin (1922, **20,** 554). In the present edition, not only have the various sections of the volume been considerably expanded, but a separate description of Trans-Jordan, occupying nearly 100 pages, has been added.

Lieut.-General Sir A. Wauchope, High Commissioner for Palestine and Trans-Jordan, in an Introduction to the new edition, describes it as giving, in an easily accessible form and in the smallest compass, accurate information on all sides of Palestinian culture. He points out that in recent years great development has taken place in the country and that it has therefore been necessary to revise and partially re-write the book. He adds : " Interest in Palestine is necessarily always great and in the past few years has constantly grown and is still increasing, and I can confidently recommend this new edition alike to all residents and travellers."

The editors have spared no pains to make the work useful and attractive, and in their Preface they pay tribute to the heads of departments and other officers of the local administrations who have assisted with expert knowledge of matters relating to their particular spheres. The general reader will probably find special interest in the portions of the Handbook dealing with geography, history and questions of race and religion, but much useful information is also furnished for tourists and on commercial and legal matters, as well as industry and technology, geology, archæology and natural history. The addition of the sections dealing with Trans-Jordan add materially to the utility and interest of the volume.

In the previous review in this Bulletin mentioned above, it was suggested that the price of the book, at that time 12*s.*, should if possible be reduced. The present issue, priced at 16*s.*, though not actually cheaper than the earlier edition, is nevertheless so in effect, in view of the increase in the number of pages from 290 to about 550.

If any criticism can be made in connection with the new issue it is that the map provided, whilst excellently printed, is somewhat diagrammatic, and gives fewer names than that which accompanied the first edition ; many of those mentioned in the Handbook itself being omitted. It is suggested that a much fuller map might be provided with the next edition.

RURAL BRITAIN TO-DAY AND TO-MORROW. By James A. S. Watson. Pp. xxiii + 161, 7½ × 5. With an Introduction by the Rt. Hon. Walter E. Elliot, M.C., M.P., and 12 illustrations. (Edinburgh and London : Oliver & Boyd, 1934.) Price 5*s*.

As stated in the Preface, this interesting little work by the Sibthorpian Professor of Rural Economy at Oxford contains the substance of a series of " broadcast talks " given in 1933, which have already been published in *The Listener*. It is an informal survey of present agricultural conditions in Great Britain as observed in the course of a tour through the country, and is both readable and instructive.

RAILWAYS AND ROADS IN PIONEER DEVELOPMENT OVERSEAS : A Study of their Comparative Economics. By J. Edwin Holmstrom, B.Sc. (Engineering), Ph.D. (Economics), A.C.G.I., Assoc.M.Inst.C.E., M.I.Struct.E. Pp. 304, 8½ × 5½. (London : P. S. King & Son, Ltd., 1934.) Price 15*s*.

The title of this volume gives a general indication of its scope, which is more fully explained in the author's preface. It is there pointed out that in some instances it is easy, in view of local considerations, to decide whether economic progress in a newly-developing district can be best assisted by railway or by road construction, but that on the other hand there are doubtful cases in which a technique is needed in order " to fix the critical conditions under which transport by rail begins to be more economical than by road, having due regard to capital, maintenance, depreciation and running costs both of the track and of the vehicles, and to all the many factors involved."

The book enters into the subject in considerable detail, and many diagrams and statistical tables are provided to illustrate the author's points and conclusions. A useful bibliography is also supplied.

Dr. Holmstrom has furnished a practical and illuminating treatise, which is well worth the attention of engineers and other authorities concerned in the promotion of transport facilities in undeveloped regions, and should be of special use in cases where a decision has not yet been reached as to the type of transport to be adopted.

IMPERIAL ECONOMY AND ITS PLACE IN THE FORMATION OF ECONOMIC DOCTRINE, 1600–1932. By C. R. Fay, M.A., D.Sc., Reader in Economic History in the University of Cambridge. Pp. 151, 7¼ × 5. (Oxford: The Clarendon Press; London: Humphrey Milford, Oxford University Press, 1934.) Price 6*s.*

This volume consists of the Beit Lectures on Colonial Economic History delivered before the University of Oxford in 1933. As will be gathered from the title, its contents cover a wide field, and the treatment of the subject is necessarily discursive, but students of Empire affairs will find in the book much that is informative and suggestive. The concluding lecture, *Ottawa: Is it Progress or Reaction?* is of topical interest as dealing with a new and unfinished chapter of economic history.

GEOGRAPHY OF NORTH AMERICA. By George J. Miller and Almon E. Parkins. Second Edition. Pp. xviii + 632, 9 × 6. (New York: John Wiley & Sons, Inc.; London: Chapman & Hall, Ltd., 1934.) Price 28*s.*

The authors of this excellent volume are engaged in geographical instruction in teachers' colleges in America, and the arrangement of the material is based on experience gained in their class work. Whilst thus written mainly for students, the book can nevertheless be strongly recommended to the general reader interested in the physical and political geography of North America. It contains a very large mass of information, which is admirably presented and throws light on numerous aspects of agriculture and industry in the vast and diversified territory concerned.

The greater part of the book is naturally occupied by a description of the United States, but a lengthy section is devoted to Canada and three chapters deal with "Mexico and Middle America." A good bibliography is provided, and the work contains a plentiful supply of illustrations, tables, maps and diagrams.

SUPPRESSION OF WEEDS BY FERTILIZERS AND CHEMICALS. By H. C. Long, B.Sc. (Agric.). Pp. 57, 8½ × 5½. (The Author: "The Birkins," Orchard Road, Hook, Surbiton, Surrey, 1934.) Price 2*s.* (by post 2*s.* 2*d.*)

This brochure gives an excellent summary of the extensive literature now available on weed destruction by chemical means, and for those who wish to go more fully into the subject, the author gives references to the original papers. After a short section on losses due to weed infestation, the effect of various substances on weeds is dealt with, including fertilisers such as lime, sulphate of ammonia, nitrate of soda and calcium cyanamide. Some of these suppress weeds by their stimulating effect on the crops, but in the case of calcium cyanamide the material appears to act, in addition, as a direct weed killer.

Of the chemicals applied primarily as weed killers, a solution of sulphuric acid is rapidly becoming a recognised means of destroying annual weeds in cereal crops, while chlorates of sodium and potassium have also come much to the fore in recent years. Other substances dealt with in the brochure include sulphates of copper and iron, finely powdered kainit, compounds of arsenic, common salt, lawn sands, etc.

Although the suppression of weeds by chemical means has proved so successful in many instances, it is important to remember, as Sir Daniel Hall mentions in his Foreword, that the use of weed destroyers " can never absolve the farmer from the traditional system of cleaning the land by well-timed cultivations under the rotations that are followed."

PRINCIPALES MALADIES PARASITAIRES DU THÉIER ET DU CAFÉIER EN EXTRÊME-ORIENT. By R. du Pasquier. Pp. 302, 10¾ × 7½. (Hanoi: Imprimerie d' Extrême-Orient, 1933.) Price $10.00.

This volume consists of a reprint of a series of articles published in *Bulletin Economique de l'Indochine* during 1932–33. It deals with all the chief insect pests, fungoid diseases, and other organisms, which attack tea and coffee plants in the region extending from India to the Philippines. In each case the distribution, description, life-history and method of control are given, the description being supplemented by numerous line drawings and an excellent series of 24 coloured plates. References to original papers are given at the end of each section. There is also a general discussion on the importance of tea and coffee pests and diseases in Indo-China and their relation to cultural methods. A separate chapter deals with the preparation and use of insecticides and fungicides, whilst the concluding part consists of a key for the identification of the various organisms dealt with.

The book should be of value to all growers of tea and coffee, who will find the coloured plates of great assistance in identifying any pest or disease occurring on their crops.

LE CAFÉ EN 1931 ET 1932, QUESTIONS ÉCONOMIQUES ET TECHNIQUES. Pp. vii + 232, 9¾ × 6¾. (Rome: International Institute of Agriculture, 1933.) Price L.20.

This publication is the first of a series of monographs on the more important tropical crops, which the International Institute of Agriculture propose to issue. It consists of a summary of the chief literature on coffee published during 1931 and 1932 and in this respect forms a continuation of the " Reviews " of coffee publications, prepared by Dr. C. J. J. van Hall, which appeared in the *International Review of Agriculture*, Vol. XXI, pp. 64–71, 415–420, 454–460 and Vol. XXII, pp. 445–462. The present volume has been compiled under the editorship of Dr. W. Balby, in collaboration with Dr. C. J. J. van Hall, and MM. V. Dore, van Aartsen, Trinchieri and J. Legros.

All aspects of coffee are dealt with, including statistics of production, consumption and prices, the position of the industry in all the producing countries of the world, cultivation, pests and diseases, and preparation. A bibliography is appended to each section. The book thus gives an excellent survey of the progress of the coffee industry during the period covered. Future issues of this series will be awaited with interest.

PHYSIOLOGICAL RESEARCHES ON MAKHORKA PLANTS (*Nicotiana rustica* L.). Vol. I. Edited by Prof. Dr. V. N. Lubimenko and Prof. A. A. Kuzmenko. Pp. 192, 10 × 6¾. (Kharkov and Kiev: All-Union Scientific Research Institute of the Makhorka Industry, 1934.)

The Makhorka plant (*Nicotiana rustica*) is a low-grade tobacco largely used for the extraction of nicotine. In 1933 results of investigations on this plant were published by the All-Union Institute for the Makhorka Industry, and also by the All-Union Institute for the Tobacco Industry, which showed that Makhorka leaves contain large quantities of citric acid and that this could be extracted from the leaves after the removal of the nicotine.

In the present volume, among the problems studied in connection with the Makhorka plant are the physiology of nicotine formation and the influence of soil moisture on its accumulation ; the respiratory mechanism of the plant ; intensity of transpiration ; vernalisation ; and the influence of the depth of planting on the growth of the plant. The only manurial question dealt with is that of the influence of boron on the development of *N. rustica*. It was found that minute quantities of boric acid increased the yield, but that the absence of the element and the application of boric acid in quantities above the optimum were both prejudicial to the plant. It is pointed out that the question of winter sowing still needs much study, and special instructions have been issued by the Institute regarding the conduct of experiments in this direction.

The British Pharmaceutical Codex 1934. An Imperial Dispensatory for the use of Medical Practitioners and Pharmacists. Published by direction of the Council of the Pharmaceutical Society of Great Britain. Pp. xxiii + 1768, 8¾ × 5¾. (London: The Pharmaceutical Press, 1934.) Price 35*s*.

The British Pharmaceutical Codex serves as a book of reference for pharmacists and medical practitioners and provides standards for the many drugs and galenical preparations which are not included in the British Pharmacopœia.

In the 1934 issue many additional chemical substances have been described, new monographs have been written on certain animal and vegetable substances, a section on surgical dressings has been included, a number of new formulæ for medicinal preparations have been introduced and many existing formulæ improved.

The present work is arranged in four parts as follows: (1) Monographs on chemical substances and drugs of vegetable and animal origin, (2) monographs on surgical dressings and the basic vegetable and animal fibres used in their manufacture, (3) the formulary section, containing the galenical and other preparations of the Codex, and (4) a series of appendixes containing tables, general tests, reagents, methods of sterilisation, and various indexes.

The work of preparing the Codex has been carried out under the supervision of the Codex Committee, consisting of the President and other members of the Council of the Pharmaceutical Society, which has been assisted by a number of Sub-Committees. The care and skill with which the book has been compiled reflect great credit on all those concerned in its production and not least on the Editor, Mr. C. E. Corfield, B.Sc., F.I.C.

The Toxicology of Plants in South Africa, together with a Consideration of Poisonous Foodstuffs and Fungi. By Douw G. Steyn, B.Sc., Dr. Med. Vet. (Vienna), D.V.Sc. *South African Agricultural Series.* Vol. XIII, pp. xii + 631, 9 × 6. (South Africa: Central News Agency, Ltd.; London: Gordon & Gotch, 1934.) Price 47*s*. 6*d*.

The author of this book is head of the Department of Pharmacology and Toxicology, Onderstepoort Laboratories, Transvaal, and has brought together the results of research work carried out at these Laboratories and elsewhere over a period of many years. The book commences with a general account of plant poisons, including their absorption by animals and mode of action, the diagnosis and general principles of treatment of cases of plant poisoning, methods of eradication of poisonous plants and the precautions necessary to avoid injury to animals.

The main portion of the book is devoted to a detailed description of poisonous plants which occur in South Africa, particularly in Eastern Cape Province, Natal and Transvaal. Each plant is treated separately, particulars being furnished as to the English, Afrikaans and native names, its distribution and the general characters by which it can be recognised. Information is given as to the active principles of the plant, so far as these are known, the symptoms produced when the plant is eaten, post-mortem appearances, treatment of affected animals, and other factors likely to be of practical use to farmers.

There is a full bibliography, containing some 650 references and a good index. The book is clearly printed and contains 135 useful illustrations of the plants dealt with.

As General the Rt. Hon. J. C. Smuts says in a Foreword, the book is bound to be of the utmost value, not only to students and professional practitioners, but also to all those who are, whether practically or otherwise, interested in South African poisonous plants.

REPORT OF THE SOCIETY OF DYERS AND COLOURISTS ON THE WORK OF ITS FASTNESS COMMITTEE IN FIXING STANDARDS FOR LIGHT, PERSPIRATION AND WASHING. Pp. 52, 8½ × 5½. (Bradford: Society of Dyers and Colourists, 1934.)

In a foreword to this handbook the President of the Society of Dyers and Colourists points out that in relation to the history of dyeing the question of fastness is of comparatively modern origin, as before the introduction of synthetic dyestuffs only a limited range of materials was used, the fastness properties of which were familiar to the trade. Under present conditions, however, it has become necessary to establish standards of fastness and standard methods of testing, and the present report gives the results of the work of a Committee specially appointed for this purpose. The report is of interest to all branches of the textile trade, and should be of great practical value in regard to laboratory methods of testing fastness and the mechanical devices employed in such work.

Arrangements have been made with the manufacturers of the mechanical devices recommended in the report for their supply on favourable terms through the Society of Dyers and Colourists. The Society has also prepared standard patterns for use by investigators, and has arranged with the Wool Industries Research Association for the testing of patterns submitted by firms and individuals not in a position to carry out the work themselves.

IDENTIFICATION OF THE TIMBERS OF TEMPERATE NORTH AMERICA. By Samuel J. Record, M.A., M.F., Sc.D. Pp. ix + 196, 9 × 6. (New York: John Wiley & Sons, Inc.; London: Chapman & Hall, Ltd., 1934.) Price 18*s*. 6*d*.

This book has been written to replace Professor Record's *Identification of the Economic Woods of the United States*, now out of print, and is in large measure a new book. The former work comprised two main sections dealing respectively with the structural and physical properties of wood, and with the identification of the useful timbers of the United States by means of a " key." The new volume has the same general arrangement, but Part I now deals with the whole field of wood anatomy in respect of woods of both temperate and tropical climates, while Part II affords means of identifying the commercial timbers of the United States and Canada. The first Part is of special interest since it is, we believe, the first instance of the employment, in a standard textbook on timber, of the anatomical terms and definitions recently adopted by the International Association of Wood Anatomists which has as one of its objects the standardisation of anatomical nomenclature in wood descriptions. The author is a prominent member of the Association and it is most satisfactory that the decisions of the special Committee on Nomenclature should receive early adoption in an important new textbook. This section forms a valuable survey of present knowledge of wood structure, but the author refers to the rapid progress being made in this fascinating study and remarks that much further research is required before an adequate account of wood anatomy will be possible. The photomicrographs, many of which are new, are admirable.

Part II has now been thoroughly revised, and in addition to the descriptive key includes under the heading of " Notes and References " short descriptive sections on each of the specific groups of timber, e.g. the white pine group, southern yellow pine, Douglas fir, etc., and thus discusses more fully a wood in both the industrial and botanical fields. The Part is accompanied by seven plates, each of six photomicrographs of timbers, and there is a valuable list of references. Altogether, the volume is a most welcome addition to timber literature.

TERMITES AND TERMITE CONTROL. A Report to the Termite Investigations Committee. Editor-in-Chief, Charles A. Kofoid, Ph.D., Sc.D. Pp. xxv + 734, 9¼ × 6¼. (Berkeley: University of California Press; London: Cambridge University Press, 1934.) Price 22*s*. 6*d*.

The Termite Investigations Committee was organised in 1928 to investigate means of combating the increasing depredations of these insects on the Pacific Coast. The Committee is composed of the Advisory Council of the University of California and of representatives of the principal contributors to its funds. The present work is in the main a series of reports of scientific and technical investigations contributed by men of science, chiefly belonging to the University of California, in co-operation with experts prominent in the large-scale production and utilisation of wood. The report deals with the biology of termites, and gives an account of the termites of the United States, Mexico, the Canal Zone, the West Indies, Hawaii and the Philippine Islands, with recommendations for prevention and control of termite damage in buildings by modified methods of construction and by the use of chemically treated and unpalatable woods.

The book is divided into four parts. The first part, devoted to the biology of the insects, is contributed by C. A. Kofoid, together with S. F. Light, Professor of Zoology, University of California, and other eminent zoologists, biologists and entomologists, including T. E. Snyder, of the Bureau of Entomology, U.S. Department of Agriculture. This section contains a vast amount of information concerning the life habits of termites, their anatomy and classification, the effect of climatic and other factors on their distribution, and the association with them of protozoa and fungi. Separate chapters deal with individual species of economic importance, and with the termite fauna of North America and of the different groups of islands mentioned above. It also includes a chapter on other wood-boring insects, such as the carpenter ants and powder post beetles, which cause similar destruction to that produced by termites.

Part II, contributed by Merle Randall, Professor of Chemistry, University of California, and other authors, contains the results of chemical investigations made with the object of rendering cellulose-containing substances immune from termite attack by impregnation with chemicals and wood preservatives, by the use of paint films, and by ground treatment with poisons. The elimination of existing termite infestations by poison dusts and fumigation was also investigated.

In the first chapter of Part III on " Termite Resistivity of Wood and Building Materials," C. A. Kofoid and E. E. Bowe, Wood Utilisation Engineer, National Lumber Manufacturers' Association, present a standardised biological method for testing the relative resistance of various woods and cellulose-containing materials to attack by termites, and its application to woods treated with preservatives. E. C. Sherrard and E. F. Kurth, chemists attached to the Forest Products Laboratory, United States Department of Agriculture, discuss the termite deterrent properties of Californian redwood (*Sequoia sempervirens*) and the distribution of the toxic material extracted by hot water, on which the resistivity of the wood depends. C. A. Kofoid records a study of the seasonal changes in wood in relation to its susceptibility to attack by fungi and termites. In the last two chapters in this section O. L. Williams deals with the relative termite resistivity of certain timbers and of various commercial wall-boards and insulating materials.

Part IV, entitled " Prevention and Repair of Termite Damage," and dealing with every aspect of this problem, opens with a chapter giving the general recommendations made by the Executive Committee for the control of termite damage. Other chapters deal specifically with buildings ; power, telephone and telegraph lines ; bridges and railroad structures ; wharves and docks, and lumber storage piles. There are also chapters on inspection and maintenance, legislative action, prevention of wood decay in buildings, and termites as a factor in earthquake damage.

Within the limits of a short review it is difficult to convey an adequate impression of the fund of information collected in this book, which will prove invaluable to all interested in the problems connected with termites and their depredations. The book contains 182 figures and illustrations, 82 tables and a useful bibliography.

PRACTICAL BACTERIOLOGY. An Introductory Course for Students of Agriculture. By Andrew Cunningham, D.Sc. Pp. viii + 203, 7½ × 5. Second edition, revised and enlarged. (Edinburgh and London : Oliver & Boyd, 1934.) Price 7*s.* 6*d.*

The author of this handbook is Advisory Bacteriologist to the Edinburgh and East of Scotland College of Agriculture, and is thus well acquainted with the requirements of the type of student for whom the work is designed. The work is of a very practical and useful type, clearly arranged, well printed, and dealing not only with general bacteriological technique in the laboratory but also with the bacteriology of agricultural products and of plant and animal diseases. Many useful illustrations and diagrams are provided.

REPTILES OF THE WORLD. By Raymond L. Ditmars, Litt.D. Pp. xx + 321, 9¼ × 6. New Revised Edition. (London: John Lane, The Bodley Head, Ltd., 1933.) Price 18*s*.

The author of this most interesting book is Curator of Mammals and Reptiles at the New York Zoological Park, and has made a special study of the various orders of reptiles, not only in captivity, but among the homes and haunts of the creatures in many parts of the world. The book is consequently of an authoritative nature, but at the same time it is written in such a way as to attract the general reader, who will find in it much entertaining matter regarding the life and habits of the alligators, crocodiles, snakes, lizards, tortoises and turtles, with which it deals.

There are no formal scientific descriptions of the animals, but the characteristics and habits of representative types from the different groups are described and for identification purposes reliance is placed on the illustrations. These, as the author himself claims, are unique, and consist of reproductions of photographs of living animals, many in their natural surroundings, and each exhibiting a characteristic pose. Altogether, there are 90 plates, illustrating nearly 200 different species, selected from those occurring in South America and the Old World, as well as in North America. The book can, therefore, be recommended to readers in any part of the world who are interested in this fascinating group of animals. The first-hand information on the habits, feeding and otherwise, of the animals will be of particular value to those who have charge of reptiles in captivity.

OUTLINES OF PHYSICAL GEOLOGY. By Chester R. Longwell, Adolph Knopf and Richard F. Flint. Pp. v + 356, 9 × 6.) New York: John Wiley & Sons, Inc.; London: Chapman & Hall, Ltd., 1934.) Price 18*s*. 6*d*.

This book is essentially an abbreviated and simplified edition of the authors' *Physical Geology*, first published in 1932. Each author has been primarily responsible for approximately one-third of the text, which has been allocated as follows: Chapters 1, 2, 6, 11, 12 and 14, dealing respectively with a general introduction to geology, weathering, wind action, diastrophism, earthquakes and mountain building, have been written by C. R. Longwell. Chapters 3, 4, 5, 7, 15 and appendix B, are by R. F. Flint, who discusses streams and valleys, sub-surface water, glaciation, the sea, and land forms, in addition to giving some observations regarding the construction and use of topographic maps. Chapters 8, 9, 10, 13, 16 and appendix A, by A. Knopf, deal respectively with sedimentary rocks, igneous rocks, volcanoes and volcanism, metamorphism, mineral resources, and brief descriptions of common minerals.

The work is particularly well illustrated, and many of the new illustrations are aerial views portraying salient geological features in a very effective way. It forms an excellent elementary introduction to the study of physical geology and should make a wide appeal among students.

MINERAL DEPOSITS. By Waldemar Lindgren. Pp. xvii + 930, 9 × 6. Fourth Edition. (New York: McGraw-Hill Book Co., Inc.: London: McGraw-Hill Publishing Co., Ltd., 1933.) Price 36*s.*

The fourth edition of this standard work on mineral deposits has been thoroughly revised and brought up to date, no attempt, however, having been made to record production statistics since 1930, in consequence of abnormal world conditions. The general arrangement of the book is essentially the same as that of previous editions, a genetic classification of minerals being adopted to give a broad and comprehensive review of the existing knowledge regarding minerals and their origin. This review is presented in 33 chapters, the first 15 of which deal substantially with general principles and information relative to mineral deposits, and occupy some 202 pages. Then follows a brief chapter of 10 pages on the classification of mineral deposits, in which is given a tabular statement of the author's genetic classification, first presented before the Geological Society of Washington in 1911. The various groups of this genetic classification are described in detail in the next 14 chapters (600 pp.) each group being illustrated by a few suitable examples of ore deposits which are considered regardless of their geographic position, although often taken from the United States. The last two chapters, namely, chapters 32 and 33, deal respectively with "Oxidation of Metallic Ores" (65 pp.) and "Metallogenetic Epochs," the latter chapter being an interesting account of the main periods of ore deposition of the world. It is noteworthy, however, that the author regards the Malayan and allied Asiatic deposits of tin and tungsten as being of Hercynian or late Palæozoic age, despite the commonly accepted view that they are late Mesozoic. The book is well planned, excellently illustrated and amply supplied with references, while the carefully compiled index of localities and subject index render the work of great value to students, for whom it is primarily designed.

LES RESSOURCES MINÉRALES DE LA FRANCE D'OUTRE-MER. II. Le Fer, le Manganèse, le Chrome, le Nickel, l'Étain, le Tungstène, le Graphite, le Glucinium, le Molybdène, le Cobalt, le Titane, le Vanadium. Pp. 436, 9¾ × 6½. (Paris : Société d'Éditions Géographiques, Maritimes et Coloniales, 1934.)

This is the second volume in the series on the mineral resources of the French possessions overseas, the first of which, on coal, was noticed in this BULLETIN, 1934, **32,** 191. It is the work of nine authors, each of whom is an expert in his own subject.

The section on iron is by G. Bétier, Director of the Geological Survey of Algeria. It occupies 80 pages and deals with the extensive deposits of iron ore in Morocco, Algeria and Tunis. The reserves of ore in these countries amount to some 300 million tons, or more than 2 per cent. of the world's total, and of this Algeria alone possesses nearly 200 million tons. Detailed descriptions of the deposits and methods of working are given, together with much geological information illustrated by numerous sketch-maps and sections. A useful survey of the market for North African iron ore with statistics up to 1931 shows that for many years Great Britain has taken half the exports of this ore from Algeria and Tunis.

Manganese ore occupies 64 pages and is by L. Neltner. The only French possessions which appear to have deposits of potential commercial importance are West Africa and Morocco. In the former, the deposits so far known are either too shallow or are situated too far from the coast to have been opened up ; but in Morocco there appear to be more promising areas, notably that near Bou Arfa, where some development work has been done. The geology of the various areas is dealt with in some detail, and the economic section includes a summary of the position in the important producing countries of the world.

Chromite, to which 40 pages are devoted, is by E. Glasser. It consists principally of a description of the deposits in New Caledonia with a brief account of the more recently discovered deposits of Co-dinh in Indo-China, and the occurrences in Togoland.

The section on Nickel is by L. Weill and occupies 60 pages. Of this, about 8 pages are given to New Caledonian deposits and the rest to the world occurrences and to the metallurgy of nickel, its uses and markets. Statistical tables show that the amount of the metal in circulation in the form of pure nickel coins amounts at present to some 22,000 tons.

Tin and tungsten are treated together and fill 92 pages. The minerals, their mode of occurrence, the deposits in Indo-China and Yunnan, and occurrences in Madagascar and New Caledonia are described by A. Lacroix, while the principal world deposits, methods of working, metallurgy, marketing and other economic aspects are dealt with by G. J. Painvin.

Graphite, by P. Bevillard, occupies 20 pages, and Cobalt, by M. Glasser, 16 pages, while the shorter sections on Beryllium, Molybdenum, Titanium and Vanadium, all by F. Blondel, occupy the remainder of the book, except for the concluding remarks by L. Guillet on the applications of various metals.

Like its predecessor, this volume is of great interest and value. It contains a mass of digested information which it would be very difficult to obtain from the scattered literature available hitherto.

MODERN ROAD EMULSIONS. A Treatise based on a Series of Lectures by Members of the Road Emulsion and Bituminous Roads Association, Ltd. Edited by F. H. Garner, M.Sc., Ph.D., F.I.C., in collaboration with L. G. Gabriel, B.Sc., M.Inst.P.T., and H. J. Prentice. Pp. 222, 8½ × 5½. (London: The Carriers Publishing Co., Ltd., 1933.) Price *12s. 6d.*

Bituminous emulsions for road-making have become so popular in recent years that any new book on the subject is likely to be received with interest by the many County and Municipal engineers and similar officials who are eager to take advantage of the exceptional properties of emulsions, but who do not feel quite at home in what is still a comparatively new development in road work. It is more particularly for such workers that this book is intended.

Brief descriptions are given of the methods of manufacture of asphaltic bitumen, and of the general characteristics of commercial bitumen emulsions. A short chapter, on the Physical Chemistry of Emulsions, attempts to explain in an elementary way the fundamental nature and properties of emulsions. Subsequent chapters deal adequately with the factors governing the breakdown of emulsions on the road, the various methods of application, and the plant used in the handling of the material.

The various tests and specifications of the British Standards Institution and Institute of Petroleum Technologists are dealt with in full, and brief descriptions are given of the specifications at present in use in Germany, United States, France and Holland. In view of the fact that the value of many tests is still largely a matter of opinion, and that much work will be necessary before the position is clarified, the criticisms of foreign specifications are, perhaps, rather severe.

The only objections to be made to the book are matters of detail. Thus, in the " Glossary of Road Emulsion Terms," " Molecule " is defined as " The smallest quantity of a substance capable of existing in the uncombined state "—a loose and inaccurate statement. Again, " Ion " is defined in terms involving the use of the word " Radical," which is not, in its turn, defined at all. Ignorance of the one term would surely imply ignorance of the other.

A good bibliography, including references to periodicals, and a series of really useful tables, complete a neat and well-illustrated work which should make an immediate appeal to all those who are engaged in the making or maintenance of roads.

GERMAN-ENGLISH CHEMICAL TERMINOLOGY. An introduction to Chemistry in English and German. By Alexander King, M.Sc., A.R.C.S., D.I.C., and Dr. Hans Fromherz. Pp. xvii + 324, 8½ × 5½. (London: Thomas Murby & Co.; Leipzig: Max Weg, 1934.) Price 12*s.* 9*d.*

This book is in the form of an introduction to chemistry, inorganic, organic and physical, arranged with the English text on the left-hand pages and the corresponding German on the right.

The idea is excellent, but some of the statements and translations given require amendment. On page 3 " titan " (titanium) is wrongly translated as " titanite," which, of course, is calcium silico-titanate. On page 91 we are told that fusion mixture is " a mixture of anhydrous potash and soda." On page 107 tin is stated to be separated from silicates and rocks, " partly by washing (elutriation) and partly by melting out on an inclined plane (liquation)." In connection with iron, iron-pyrites is given the first place among ores of this metal, and we are told that in the blast furnace " linings of silica or limestone are added to the charge as a flux."

Apart from these and other such blemishes, the book should be very useful to students wishing to obtain a working knowledge of German chemical terminology.

BOOKS RECEIVED FOR NOTICE

THE PHYSIOGRAPHY AND VEGETATION OF TRINIDAD AND TOBAGO. A Study in Plant Ecology. By R. C. Marshall, B.Sc., M.A., Dip.For. Oxford Forestry Memoirs, Number 17, 1934. Pp. 56, 10¾ × 7½. (Oxford: The Clarendon Press; London: Mr. Humphrey Milford, Oxford University Press, 1934.) Price 6*s.*

THEORY AND PRACTICE OF SILVICULTURE. By Frederick S. Baker, F.E. Pp. xiv + 502, 9 × 6. (New York and London: McGraw-Hill Book Company, Inc., 1934.) Price 30*s.*

IDENTIFICATION OF THE COMMERCIAL TIMBERS OF THE UNITED STATES. By H. P. Brown, Ph.D., and A. J. Panshin, Ph.D. Pp. xxvi + 223, 9 × 6. (New York and London: McGraw-Hill Book Company, Inc., 1934.) Price 18*s.*

ARSENICAL AND ARGENTIFEROUS COPPER. By J. L. Gregg. Pp. 189, 9 × 6. (New York: The Chemical Catalog Company, Inc., 1934.) Price $4.00.

RÉPERTOIRE INTERNATIONAL DES SOCIÉTÉS ÉLECTROCHIMIQUES ET ÉLECTROMÉTALLURGIQUES, 1934. Pp. 206, 9½ × 6½. (Paris: Société des Publications Minières et Métallurgiques, 1934.) Price 75 francs.

CONDUCTOMETRIC ANALYSIS. PRINCIPLES, TECHNIQUE, APPLICATIONS. By Hubert T. S. Britton, D.Sc., B.Sc., D.I.C., F.I.C. Being Volume Eight of a Series of Monographs on Applied Chemistry under the editorship of E. Howard Tripp, Ph.D. Pp. xi + 178, 8½ × 5½. (London: Chapman & Hall, Ltd., 1934.) Price 12*s.* 6*d.*

REPORTS OF RECENT INVESTIGATIONS AT THE IMPERIAL INSTITUTE

Selected from the Reports made to the Dominion, Colonial and Indian Governments

ESSENTIAL OILS FROM SEYCHELLES

THE production of essential oils in Seychelles has long been an important industry in the Colony, and much experimental work has been carried out by the Department of Agriculture, not only with oils of established commercial importance, but also with a view to finding others likely to be worth developing. The Imperial Institute has assisted in this work by examining and reporting on samples of the oils. Many reports on such investigations have been published already in this BULLETIN. For convenience, the following list of references may be quoted: lemongrass (1908, **6**, 108; 1920, **18**, 340); citronella (1908, **6**, 109; 1920, **18**, 339); palmarosa (1927, **25**, 112); gingergrass (1927, **25**, 113); vetiver roots (1912, **10**, 33); eucalyptus (1931, **29**, 134); patchouli (1924, **22**, 271; 1929, **27**, 289); *Ocimum viride* (1917, **15**, 322; 1920, **18**, 348); *O. gratissimum* (1918, **16**, 33; 1924, **22**, 275); *O. basilicum* (1918, **16**, 34); cinnamon bark oil (1908, **6**, 111); cinnamon leaf oil (1924, **22**, 273); clove leaf oil (1908, **6**, 111); ylang-ylang (1908, **6**, 110; 1914, **12**, 228); cananga (1908, **6**, 111); essence de Bigarade (1908, **6**, 110); Mozambique orange oil (1908, **6**, 110); ginger oil (1926, **24**, 654).

During more recent years and particularly since Mr. Holdsworth Haines's investigation of the industry in 1932–33, further samples of oils of different kinds have been examined at the Imperial Institute and the reports relating thereto are printed in the following pages. For an account of the present position of the Seychelles industry and the possibility of improvement, reference may be made to

Mr. Holdsworth Haines's article published later in this BULLETIN (p. 545).

CITRONELLA AND LEMONGRASS OILS

Several species of *Cymbopogon*, yielding oils of the citronella, lemongrass or similar type, occur in the Seychelles and have been distilled experimentally by the Department of Agriculture. Samples of such oils, received at the Imperial Institute during the last year or two, are dealt with below. They are arranged according to their botanical origin, as determined from herbarium material submitted to Kew.

Cymbopogon Nardus (L.) Rendle

(Citronella Oil)

Two specimens of this oil were forwarded in November 1933 and March 1934, respectively. They were as follows:

No. 1 (" No. 5 ").[1]—This consisted of clear, pale yellowish-brown oil.

No. 2 (" No. 8 ").—This oil was somewhat turbid owing to the presence of moisture. After filtration through paper the oil was clear and of brownish-yellow colour.

The oils were found to have the following constants (see table on page 513), which are shown in comparison with the figures recorded for commercial Ceylon and Java citronella oils.

Sample No. 1 (" No. 5 ") had the characteristic odour of citronella oil, but possibly rather weaker than that of good Ceylon oil. Its constants were in general agreement with those of Ceylon citronella oil. This sample was submitted to a firm of importers in London, who furnished the following observations:

> " From the analysis this oil resembles very much what is known as ' Estate Quality Ceylon Oil,' that is to say, a pure Ceylon oil, without the usual percentage of kerosene. The total acetylisable constituents of Ceylon Estate Oil run between 60 and 65 per cent., and to-day's value is approximately 1*s*. 2¾*d*. to 1*s*. 3*d*. per lb. c.i.f. (January 1934).

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[1] The numbers in brackets refer to the original numbers allotted to the oils in Seychelles.

—	No 1.	No 2	Commercial citronella oils.	
			Ceylon	Java
Specific gravity at 15·5/15·5° C	0·9042	0·9012	0·895 to 0·910	0·885 to 0·895
Optical rotation α_D . .	−14·20° at 22° C	−14·15° at 21° C	−7° to −18°	0° to −3° (rarely slightly positive)
Refractive index n_D20° C .	1·4800	1·4790	1·479 to 1·485	1·468 to 1·472
Aldehydes (expressed as citronellal) by hydroxylamine method,[1] per cent by weight	7·1	7·7	6·5 to 8	35 to 46
Ester value after acetylation	211·5	205·5	—	—
Equivalent to total acetylisable constituents (expressed as $C_{10}H_{18}O$), *per cent*	69·1	66·8	55 to 65	80 to 92
Solubility in 80 per cent alcohol at 15·5° C . .	Soluble in 1·1 vols	Soluble in 1·0 vol	Soluble in 1·5 vols	Soluble in 2 vols, becoming not more than slightly opalescent with 10 vols

[1] *The hydroxylamine method is that recognised by the Society of Public Analysts for the estimation of citronellal in citronella oil.*

" The odour of the Seychelles oil is not particularly attractive at first, but improves after exposure to the air, and we think that there would be a market for considerable quantities if it can be produced at a competitive price. In order to introduce it, it would probably be necessary to undercut the Ceylon price at first, but eventually we think it would sell on equal terms or possibly command a very small premium."

Sample No. 2 (" No. 8 ") closely resembled No. 1, but its odour was somewhat stronger. The oil was submitted to a firm of essential oil distillers in London, who furnished the following observations :

" This is very similar to Ceylon citronella oil on figures and on odour. The borneol content is probably lower than that of Ceylon citronella oil. It would have to compete with Ceylon citronella oil in price."

The price of Ceylon citronella oil in London in December 1934 was 1*s.* 0½*d.* per lb. c.i.f.

Cymbopogon citratus (DC.) Stapf.
(Lemongrass Oil)

A sample of this oil ("No. 6") was forwarded in November 1933. It consisted of a clear, pale yellowish-brown oil.

The oil was examined with the following results, which are shown in comparison with the corresponding figures recorded for East Indian lemongrass oil.

	"No 6"	East Indian lemongrass oil
Specific gravity at 15·5/15·5° C	0·9026	0·895 to 0·907
Optical rotation α_D	$-0·15°$ at 19° C	$+1°$ to $-5°$
Refractive index $n_D 20°$ C	1·4884	1·4825 to 1·4885
Aldehydes (bisulphite method[1]), per cent by volume	86·5	70 to 85
Solubility in alcohol at 15·5° C	Soluble in 0·7 vol of 80 per cent alcohol Not soluble in 10 vols of 70 per cent	Soluble in 3 vols of 70 per cent alcohol

[1] *The bisulphite method is the approved commercial method for the estimation of citral in normal lemongrass oils*

This oil was a lemongrass oil of satisfactory odour and contained a high percentage of citral, the amount being above the average for commercial samples of Cochin lemongrass oil. It will be observed that the oil was insoluble in 70 per cent. alcohol, and in consequence it would be classed as an "insoluble" oil. The trade at one time generally preferred "soluble" lemongrass oil, mainly because this character was taken as an indication that the oil had been well prepared and properly stored, but little importance is attached at present to this property as the oil is now employed principally as a source of citral.

Lemongrass oil from Seychelles of the quality of the present sample (containing 86·5 per cent. of citral) should be readily saleable in competition with Cochin lemongrass oil, which in December 1934 was quoted in London at about 3*s.* 6*d.* per lb. spot.

Other Cymbopogon Oils

"*No.* 1."—*Cymbopogon flexuosus* (Nees) W. Watson? or possibly a hybrid between *C. flexuosus* and *C. Nardus.*

"*No.* 2."—*Cymbopogon flexuosus* (Nees) W. Watson.

" *No.* 3."—*Cymbopogon confertiflorus* (Steud.) Stapf.

These samples were forwarded in August 1933. As received, the oils were slightly turbid owing to the presence of moisture, but after filtration through paper they were clear and pale brownish-yellow.

The odour of Sample 2 resembled that of a low-grade lemongrass oil. The odours of Samples 1 and 3 were suggestive of a mixture of lemongrass and citronella oils, that of No. 3 being, however, much superior to that of No. 1.

The oils were found to have the following constants (see table on page 516), which are shown in comparison with the ranges of corresponding figures recorded for commercial Ceylon and Java citronella oils and for East Indian lemongrass oil.

The foregoing results show that Sample No. 2, containing 62 per cent. of citral, possesses the characters of a low-grade lemongrass oil, whilst the constants of Nos. 1 and 3 are more in agreement with those of citronella oils. As previously mentioned, the odour of these latter samples suggested a mixture of lemongrass and citronella oils.

The composition of the aldehyde portion of Samples Nos. 1 and 3 was not determined. If citral is present in these oils, as is indicated by the high figures for ester value after acetylation (particularly in the case of No. 3), it is not in sufficient quantity to be worth extraction, and the value of such oils would therefore depend principally on their odour.

The three oils were submitted to a firm of importers in London, who described No. 2 as a low-grade lemongrass oil of poor odour, and stated that for this reason and the fact that it contained only 62 per cent. of citral it could not compete with the commercial lemongrass oils now on the market. It would in their opinion be difficult to find a sale for such oil in the United Kingdom.

As regards the other samples, the firm regarded these oils, and especially No. 1, as very inferior in odour to commercial citronella and lemongrass oils and stated that it would be difficult to secure a regular market for them.

The results recorded above indicate that these oils are all of inferior quality. No. 2 is the best and possesses the

—	Present samples			Ceylon citronella oil	Java citronella oil	East Indian lemongrass oil
	No 1	No 2	No 3			
Specific gravity at 15 5/15 5° C	0 9209	0 9125	0 9014	0 895 to 0 910	0 885 to 0 895	0 895 to 0 907
Optical rotation a_D	− 5 31° at 24° C	− 1 47° at 24° C	− 0 33° at 26° C	− 7° to − 18°	0° to − 3° (rarely slightly positive)	+ 1° to − 5°
Refractive index $n_D 20°$ C	1 4876	1 4862	1 4762	1 479 to 1 485	1 465 to 1 472	1 4825 to 1 4885
Aldehyde (bisulphite method [1]), per cent by volume	23 5	62	39	—	—	70 to 85
Aldehydes, expressed as citronellal (hydroxylamine method [2]), per cent by weight	22 4	Not determined	46 8	6 5 to 8	35 to 46	—
Ester value after acetylation	222 0	,,	295 3	—	—	—
Equivalent to total acetylisable constituents (expressed as $C_{10}H_{18}O$) *per cent*	73 2	,,	103 4	55 to 65	80 to 92	—
Solubility in 80 per cent alcohol at 15 5° C	Soluble in 0 9 vol with slight opalescence	Soluble in 0 7 vol	Soluble in 0 9 vol	Soluble in 1 5 vols	Soluble in 2 vols, becoming not more than slightly opalescent with 10 vols	Soluble in 3 vols of 70 per cent alcohol

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[1] *The bisulphite method is the approved commercial method for the estimation of citral in normal lemongrass oils*

[2] *The hydroxylamine method is that recognised by the Society of Public Analysts for the estimation of citronellal in citronella oil*

characters of a low-grade lemongrass oil. Nos. 1 and 3 are not representative of either normal lemongrass oil or normal citronella oil. Owing to their poor quality, such oils would probably be difficult to dispose of, except at very low and unremunerative prices, and their production therefore cannot be recommended.

It may be mentioned that *C. confertiflorus* is one of the wild " mana " grasses of Ceylon. Samples of the Ceylon oil examined at the Imperial Institute some years ago were found to be inferior to Ceylon citronella oil and of little commercial interest (see this BULLETIN, 1911, **9**, 242).

PALMAROSA AND GINGERGRASS OILS

Palmarosa and gingergrass oils are derived from two varieties of *Cymbopogon Martini*, known respectively as " Motia " and " Sofia." The two forms appear to be indistinguishable from their morphological characters alone, although it is possible for one experienced in handling the plants to separate them by their odour. Seed of both kinds was introduced into the Seychelles from India in 1923 and distributed to planters, so that the two plants now occur in the islands.

Palmarosa oil is of better quality than gingergrass oil, having a much finer odour, and although there is not much difference in the market price (5*s.* 3*d.* as against 4*s.* 9*d.* per lb. c.i.f., December 1934), there is a greater demand for palmarosa oil. For this reason the Department of Agriculture in the last year or two have been working up a stock of plants, and in September 1933 the Imperial Institute was informed that 3,000 plants had been raised vegetatively from six plants isolated by Mr. Holdsworth Haines less than a year previously.

The habit of the type now being grown is upright and regular. Attempts have been made to raise the plant from seed on several occasions, but each time the seed failed to germinate ; neither have seedlings been found growing in the stock beds. On the other hand, seedlings of gingergrass (" Motia ") are stated to be constantly appearing on the land formerly occupied by the plants.

The following account of distillation experiments recently carried out with the heads and stems of young and finely divided clumps of palmarosa grass growing in nursery beds has been furnished by the Director of Agriculture.

The area covered by the beds was 1,500 square ft., which yielded at one cutting 190 kilos. of heads and stems, equivalent to a yield of about 5·5 tons to the acre.

The distillations recorded below are from a cutting which commenced on the December 15, 1933, the previous cutting having been made on October 17, 1933.

Distillation	Quantity	Yield
1st	28 kilos	2·5 litres per ton.
2nd	22 ,,	2·5 ,, ,, ,,
3rd	22 ,,	2·5 ,, ,, ,,
4th	22 ,,	3·2 ,, ,, ,,
5th	23 ,,	3 2 ,, ,, ,,
6th	20 ,,	3 ,, ,, ,,
7th	20 ,,	3 ,, ,, ,,

It is suggested that the difference in yield is probably due to some of the grass having been cut during rain-showers.

Heads and stems distilled separately gave the following results :

	Quantity	Yield
Heads	10 kilos.	7 litres to the ton.
Stems	23 ,,	1·3 ,, ,, ,,

Samples of both palmarosa and gingergrass oils distilled experimentally in the Seychelles have been examined at the Imperial Institute in recent years, and the results are given below.

Palmarosa Oil

A sample of oil, stated to have been distilled from the older leaves of an erect grass supposed to be palmarosa of the true Motia type was forwarded in November 1931. The yield recorded was 63·5 grams from 21·8 kilos. of leaves.

The sample consisted of a pale yellowish-brown oil having the characteristic odour of palmarosa oil.

The oil was examined with the following results, which are shown in comparison with the ranges of recorded figures for palmarosa oil :

	Present sample.	Recorded figures for palmarosa oil.
Specific gravity at 15·5/15·5° C.	0·9083	0·887 to 0·90
Optical rotation α_D	+ 3·1 at 20° C.	+ 6° to − 3°
Refractive index n_D20° C.	1·4796	1·472 to 1·477
Acid value	1·4	0·5 to 3·0
Ester value	46·1	12 to 48
Ester value after acetylation	262·3	226 to 274
Equivalent to "total geraniol," *per cent*	89·8	74·8 to 94·8
Solubility in 70 per cent alcohol at 15·5° C.	Soluble in 1·6 vols.	Soluble in 1·5 to 3 vols.

These results show that the sample was a palmarosa oil of good quality.

Two further samples, distilled from the selected plants already referred to, were forwarded in November 1933. They were as follows:

No. 1 (*September*).—A clear, pale greenish-yellow oil, from which a few drops of water had separated.

No. 2 (*November*).—A clear, reddish-brown oil.

The oils were examined with the following results, which are shown in comparison with those of the foregoing sample and with the figures recorded for commercial palmarosa oil:

—	Present samples		Previous sample	Recorded figures for Indian palmarosa oil
	No 1	No 2		
Specific gravity at 15·5/15·5° C.	0·8960	0·8968	0·9083	0·887 to 0·90
Optical rotation α_D	+ 0·03° at 24° C	− 0·22° at 18° C.	+ 3·1° at 20° C	+ 6° to − 3°
Refractive index n_D20° C.	1·4715	1·4722	1·4796	1·472 to 1·477
Acid value	1·2	1·0	1·4	0·5 to 3·0
Ester value	97·2	90·3	46·1	12 to 48
Ester value after acetylation	276·1	273·5	262·3	226 to 274
Equivalent to "total alcohols" (expressed as geraniol) *per cent*	95·8	94·6	89·8	74·8 to 94·8
Solubility in 70 per cent alcohol at 15·5° C.	Soluble in 1·8 vols.	Soluble in 1·6 vols.	Soluble in 1·6 vols	Soluble in 1·5 to 3 vols.

These results indicate that the present oils, giving a high figure for "total alcohols," were obtained from the Motia type of grass from which the palmarosa oil of commerce is derived. The oils contained, however, an abnormally high percentage of esters, so that the percenttages of free geraniol in the oils (indicated by the difference between the ester value before and after acetylation) were rather low compared with those present in good commercial samples of palmarosa oil and also in the earlier sample from Seychelles.

The odour of sample No. 1 was very pleasant and devoid of any suggestion of gingergrass oil, but as it contained less free geraniol the odour was not so strong as that of the previous sample. The odour of No. 2 was less pleasant than that of No. 1.

The samples were submitted to a firm of essential oil distillers in London, who reported on them as follows :

" *No.* 1.—The high specific gravity and low refractive index is in keeping with the high ester value. The oil has a sweeter note than Indian oil and is slightly more geranium-like. The oil yields a very sweet-smelling geraniol and seems to be free from gingergrass odour.

" *No.* 2.—This sample also has a high specific gravity, low refractive index and high ester value. The first odour is not very sweet, but after exposing on filter paper for about four hours the less volatile oil develops a very sweet odour, that of geranyl acetate being very pronounced. Geraniol produced by saponification is very sweet and clean, but not quite so nice as Sample No. 1.

" Both types should find a good market, both for production of geraniol and for use in good-class toilet soap, where the high percentage of esters (33 per cent. calculated as geranyl acetate) would be very useful in rose compounds.

" From the above it would be apparent that on odour the oil in question is rather better than that from India. There is no question that oils of the palmarosa type have a specific use in connection with the preparation of rose odours, but their market is limited and of late years the demand for Indian palmarosa oil has been a decreasing one. The present price of the Indian oil is somewhere in the neighbourhood of 5*s.* 9*d.* to 6*s.* per lb. c.i.f. (January 1934)."

In a subsequent communication the Director of Agriculture suggested that the small difference noted between these two samples of oil was probably due to the fact that the material from which sample No. 2 was obtained had fermented slightly.

Gingergrass Oils

Two samples of gingergrass oils were forwarded, respectively, in September and October 1931. The first had been distilled from plants with a recumbent habit, whilst the second had been distilled from young erect plants. They were examined with the following results, which are shown in comparison with the corresponding figures recorded by Gildemeister for gingergrass oils :

	No 1	No 2	Recorded figures for gingergrass oil.
Specific gravity at 15·5°/15·5° C	0·9479	0·9525	0·90 to 0·953
Optical rotation, α_D . .	Oil too dark for determination	+ 26·02° at 21° C	+ 54° to − 30°
Refractive index, n_D20° C .	1 4920	1·4930	1 478 to 1·493
Acid value . . .	3 1	0 3	up to 6·2
Ester value . . .	45·4	20·5	8 to 29
Ester value after acetylation	200 9	166·0	120 to 200
Equivalent to " total geraniol " . . *per cent*	65·1	51·1	36·2 to 64·7
Solubility in 70 per cent alcohol at 15·5° C . .	Soluble in 1·7 vols.	Soluble in in 1·8 vols.	Soluble in 2 to 3 vols.

The odour and characteristics of sample No. 1 suggested that it had been derived from a mixture of gingergrass and palmarosa grass, with the former predominating. No. 2 contained less total alcohols and was inferior in odour ; it resembled more closely ordinary gingergrass oil.

EUCALYPTUS CITRIODORA

Eucalyptus citriodora is grown in the Seychelles in hedges and can be clipped every three months. Material thus obtained yields on distillation 20 litres or more of oil from a ton of green leaves, and consequently much attention is being given to the propagation of the tree. Distillation experiments have recently been carried out by the Department of Agriculture at the Botanical Gardens, and the following report on the results has been kindly furnished by the Acting Director.

The trees from which the material was obtained are recorded to have been planted in November 1931, and to have received their first cropping six months later. Since this time they have been cropped at intervals of two to four months. The trees, 84 in number, were set out on a walled bank of transported red earth in two rows 3 ft. apart by 3 ft. between each tree. For the first cropping, the trees were pruned back to an average height of 2 ft. 6 in. In subsequent croppings it has been the practice to prune back to a few inches above the previous cutting to secure a vigorous break from buds on the younger wood. The average height at which the trees were pruned at the last cutting was 4 ft. 6 in. As the heights of pruning will progressively increase, an experiment has been started to ascertain the minimum amount of new wood which requires to be left to ensure vigorous new growth. It has been noted that this tree, when subjected to severe pruning, tends to throw all its energies into the development of two or three main shoots. This tendency to perpendicular rather than lateral development shows that close spacing can safely be practised compatible with suitable soil conditions.

During 1933 this plot of trees was cropped on the following dates: March 9, June 16, September 20. The data given below are from the cropping which commenced on January 31, 1934.

The first 40 trees, showing slightly better growth than the remainder, were cropped in batches of 10 trees each, and gave the following results:

Weight of fresh leaves per 10 trees = 16·25 kilos.
" " stems " " = 13·8 "

Results of distillations were as follows:

Distillation.	Quantity distilled *kilos.*	Yield per ton *litres.*
No. 1.	22	20·45
" 2.	15	23
" 3.	14½	23
" 4.	15	22
" 5.	15	23
" 6.	13½	23

N B—No. 5 consisted of smooth or glabrous leaves, and No. 6 of the hairy or pilose type of leaf.

The average time taken for each distillation was 1 hour 40 minutes, and the weight of steam used for the first distillation was 38·75 kilos.

Forty-two kilos. of fresh leaves were allowed to dry for fifteen days, and were then weighed and distilled. The leaves when dry weighed 21 kilos. Two distillations were made, and these yielded oil at the rate of 45 litres to the ton.

The weight of dried leaves required to charge the still was found to be about half that required when charging with fresh leaves.

On distillation of the twigs (7½ kilos.) no oil was obtained.

A number of samples of *E. citriodora* oil distilled in Seychelles have been examined at the Imperial Institute during the last two years and the reports which have been furnished to the Governor are given below.

Report No. 1

This sample was forwarded in September 1933. It consisted of clear, very pale greenish-yellow oil with the characteristic odour of *E. citriodora*.

The oil was examined with the following results, which are shown in comparison with figures recorded by Gildemeister and by Penfold for *E. citriodora* oil:

—	Present sample	Recorded figures	
		Gildemeister	Penfold
Specific gravity at 15/15° C	0·8673	0·864 to 0·894	0·8607 to 0·8761
Optical rotation a_D	+ 0·95° at 20° C	− 1·15° to + 3·5°	− 0·25° to + 2·0°
Refractive index n_D20° C.	1·4514	1·449 to 1·463	1·4498 to 1·4575
Acid value	2·9	—	—
Ester value	10·4	—	—
Ester value after acetylation	285·0	—	—
Equivalent to total acetylisable constituents (expressed as $C_{10}H_{18}O$) *per cent.*	99·7	Up to 98·5	—
Aldehydes (expressed as citronellal) *per cent.*	81·1[1]	—	62·7 to 85·5[2]
Solubility in 70 per cent. alcohol at 15·5° C.	Soluble in 3·0 vols	Soluble in 1 1½ vols. Frequently only in 10 vols.	Soluble in 1·3 to 1·7 vols.

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[1] *By the hydroxylamine method as recognised by the Society of Public Analysts (" Analyst," December* 1932).

[2] *By Penfold and Arneman's modification of Holtappel's hydroxylamine method (" Perfumery and Essential Oil Record,"* 1929, **20**, 392).

These results show that the present oil is of good quality and contains a high percentage of citronellal.

The information supplied by the Director of Agriculture indicates that the yield of oil from *E. citriodora* leaves distilled in Seychelles is about 1·7 per cent. According to Penfold the leaves of cultivated trees in Australia yield 1·0 to 1·6 per cent., whilst the normal yield is stated to be 0·8 per cent.

The oil was submitted to (*a*) essential oil distillers and (*b*) importers in London, who furnished the following reports respectively:

(*a*) " The oil is of excellent odour value, but its use in this country is very restricted and does not, in our opinion, amount to more than a few cwt. per annum. Its chief use is for pharmaceutical purposes, particularly for inhalants. With the above limitations its value is about 5*s*. per lb."

(*b*) " We have compared this sample for odour with the citriodora oil of a standard quality which we receive from Australia, and although we find that the Seychelles oil differs from Australian oil in many respects, still it is an oil of good quality, and if it could be offered at a price to compete with other oils of a similar nature we think there is a chance of business. The Australian oil of the best grade is offering for shipment at 4*s*. 6*d*. to 5*s*. per lb. c.i.f., but at this price the citriodora oil can only be used in comparatively small quantities, and unless the producers can supply oil at a considerably lower price we are afraid that we cannot hold out hopes of an increase in consumption.

" We note that the yield of oil from the leaves is about 1·7 per cent. With such a yield, and provided there are sufficiently large supplies of the leaves available, we should think that the oil could be made profitably in the Seychelles at a figure much below that asked by the Australian distillers. If the Seychelles oil could be produced and offered at 1*s*. 6*d*. per lb. or thereabouts, we are of opinion that we could find fresh outlets for the oil here and abroad in sufficiently large quantities to make it attractive to the producer. For the purposes that we have in mind the oil would have to compete in price with oils of a similar odour and character, such as Java citronella oil.

"We cannot recommend the production of *E. citriodora* oil if the producers have to ask a price in the region of 4*s*. per lb."

This oil was of satisfactory quality and should be saleable, but as indicated in the trade reports quoted above it might not find an outlet at more than 1*s*. 6*d*. per lb. under present conditions, as the limited demand for *E. citriodora* oil for certain purposes is easily met by existing supplies, and if large quantities were placed on the market they would have to compete with Java citronella oil. The price of Java citronella oil in London at that time was 1*s*. 2½*d*. per lb. c.i.f. (November 1934).

Report No. 2

The four samples which are the subject of this report were forwarded in April 1934. They were as follows :

No. 1.—Distilled on February 22, 1934, from leaves which had been allowed to dry under shade to 50 per cent. of their original weight.

No. 2.—Distilled on January 31, 1934, from fresh leaves.

No. 3.—Distilled on February 6, 1934, from hairy or pilose leaves.

No. 4.—Distilled on February 1, 1934, from smooth or glabrous leaves.

Each sample consisted of clear, very pale greenish-yellow oil. They all possessed the pleasant characteristic odour of *E. citriodora* oil, No. 1 being somewhat inferior to the others in this respect. The odour of No. 3 was slightly sweeter than the rest, whilst between Nos. 2 and 4 no difference could be detected.

The oils were examined with the following results (see table on page 526), which are shown in comparison with those obtained for the previous sample of *E. citriodora* oil from Seychelles, and with figures recorded by Gildemeister and by Penfold for *E. citriodora* oil.

The oils were submitted to the firm of importers in London who were consulted regarding the previous sample.

—	Present samples				Previous sample	Recorded figures	
	No 1	No 2	No 3	No 4		Gildemeister	Penfold.
Specific gravity at 15·5/15·5° C.	0·8686	0·8675	0·8710	0·8655	0·8673	0·864 to 0·894	0·8607 to 0·8761
Optical rotation α_D	+ 0·84° at 20° C	+ 1·00° at 20° C	+ 1·36° at 20° C	+ 1·24° at 19° C	+ 0·95° at 20° C	− 1·15° to + 3·5°	− 0·25° to + 2·0°
Refractive index n_D20° C.	1·4520	1·4510	1·4513	1·4506	1·4514	1·449 to 1·463	1·4498 to 1·4575
Acid value	2·8	3·6	5·5	2·5	2·9	—	—
Ester value	8·6	9·3	11·0	9·5	10·4	—	—
Ester value after acetylation	288·9	281·9	286·3	284·2	285·0	—	—
Equivalent to total acetylisable constituents (expressed as $C_{10}H_{18}O$) . . *per cent*	101·1	98·3	100·2	99·3	99·7	Up to 98·5	—
Aldehydes (expressed as citronellal) . . *per cent.*	79·2[1]	80·9[1]	82·0[1]	82·6[1]	81·1[1]	—	62·7 to 85·5[2]
Solubility in 70 per cent. alcohol at 15·5° C.	Soluble in 3·2 vols	Soluble in 2·9 vols	Soluble in 3·1 vols	Soluble in 3·3 vols	Soluble in 3·0 vols.	Soluble in 1 to 1½ vols Frequently only in 10 vols.	Soluble in 1·3 to 1·7 vols.

[1] *By the hydroxylamine method as recognised by the Society of Public Analysts ("Analyst," December* 1932)

[2] *By Penfold and Arneman's modification of Holtappel's hydroxylamine method (" Perfumery and Essential Oil Record,"* 1929, **20**, 392).

They furnished the following observations on the present oils :

" On comparing these samples for odour, we do not find much difference between Nos. 2, 3 and 4. We do not, however, regard No. 1 as of a suitable odour. It is difficult to say which is the best of 2, 3 or 4, but in view of the analysis we think that No. 4 should have the preference.

" We would draw your attention to our letter of March 6 about the prospects of selling *E. citriodora* oil in quantity. Since that date Java citronella oil has fallen in price, and would be much cheaper than it is for United Kingdom users if the English and Dutch exchange were nearer par.

" The demand for *E. citriodora* oil for perfumery and medicinal purposes at 4*s.* 6*d.* to 5*s.* per lb. is still very poor, and likely to be in our opinion. The only chance the oil has of selling in quantity is if it is offered at a price to compete with similar oil from other sources. If the distillers think they can produce profitably at a competitive price, we will see if we can interest some users."

The importers subsequently submitted the samples to one of their customers who uses *E. citriodora* oil for a particular purpose. This customer considered No. 1 to be the best for this purpose and next to it No. 4, but stated that there was little difference between these two oils.

The foregoing results show that there were no very marked differences between the four oils and that they were similar in character to the previous sample from Seychelles. They all contained high percentages of the chief constituent, citronellal. Sample No. 1 contained less of this aldehyde than the three other oils, and both the Imperial Institute and the importers considered the odour of this sample to be not quite so satisfactory as that of the other three oils or of the previous sample from Seychelles. On the other hand, a user of *E. citriodora* oil selected No. 1 as the best for his purpose, but stated that there was little difference between that sample and No. 4. The preference for one of the four oils over the others would thus seem to be a matter of individual judgment.

The odour of oil No. 3, from the pilose type of leaves, appeared to be slightly sweeter than that of No. 4 from the glabrous leaves.

It seems unlikely that there would be any material difference in the market values of the four oils, but should it be confirmed that the drying of the leaves before distillation (as in the preparation of sample No. 1) slightly affects the quality of the oil, any slight reduction in the market value may be fully compensated by the lower cost of distillation owing to the larger quantity of leaves which can be dealt with in the still at one operation.

It was suggested that a larger quantity (2 to 3 lb.) of the oil distilled from the dried leaves might be prepared and forwarded for further examination and submission to likely users for their opinion as to its quality and value.

Report No. 3

This sample was forwarded in September 1934. It had been distilled from the dried leaves and was sent in accordance with the suggestion made in the preceding report.

The sample consisted of about two pints of slightly turbid oil, which after filtration was clear and of a pale greenish-yellow tint, somewhat darker than that of the samples of *E. citriodora* oil previously submitted from Seychelles.

The oil was found to have the following constants (see table on next page), which are shown in comparison with the ranges of corresponding figures obtained for the samples dealt with in the two previous reports and those recorded by Gildemeister and by Penfold for the oil of *E. citriodora.*

From these results it will be seen that the constants of the present oil were generally similar to those of the previous samples of *E. citriodora* oil received from Seychelles. Although the oil gave a very high figure for "total acetylisable constituents" it contained a rather lower percentage of citronellal than the earlier samples.

The oil was forwarded to the essential oil importers in London who had reported on the previous samples and had offered to submit the oil to likely users if a larger quantity could be supplied for the purpose. The firm, after consult-

—	Present sample.	Previous samples from Seychelles.	Recorded figures.	
			Gildemeister.	Penfold.
Specific gravity at 15·5/15·5° C.	0·8673	0·8655 to 0·8710	0·864 to 0·894	0·8607 to 0·8761
Optical rotation a_D	+ 1·13° at 21° C.	+ 0·84° to + 1·36° to 20° C.	− 1·15° to + 3·5°	−0·25° to +2·0°
Refractive index $n_D20°$ C.	1·4520	1·4506 to 1·4520	1·449 to 1·463	1·4498 to 1·4575
Acid value	3·0	2·5 to 5·5	—	—
Ester value	7·9	8·6 to 11·0	—	—
Ester value after acetylation	289·7	281·9 to 288·9	—	—
Equivalent to "total acetylisable constituents" (expressed as $C_{10}H_{18}O$) *per cent.*	101·4	98·3 to 101·1	up to 98·5	—
Aldehydes (expressed as citronellal) *per cent.*	78·7[1]	79·2 to 82·6[1]	—	62·7 to 85·5[2]
Solubility in 70 per cent. alcohol at 15·5° C.	Soluble in 3·5 vols.	Soluble in 2·9 to 3·3 vols.	Soluble in 1 to 1½ vols. Frequently only in 10 vols.	Soluble in 1·3 to 1·7 vols.

[1] *By the hydroxylamine method as recognised by the Society of Public Analysts* ("*Analyst,*" *December* 1932).

[2] *By Penfold and Arneman's modification of Holtappel's hydroxylamine method* ("*Perfumery and Essential Oil Record,*" 1929, **20,** 392).

ing consumers, reported that there was a demand among their clients for the oil at the price of 1*s.* 6*d.* per lb., and that they would be glad to obtain supplies as early as possible.

The results of this investigation indicate that a market can be found in the United Kingdom for Seychelles *E. citriodora* oil distilled from the dried leaves if it can be offered at a suitable price.

At a recent meeting of the Imperial Institute Advisory Committee on Essential Oils, considerable interest was shown in the samples of *E. citriodora* oil from Seychelles which were considered to be of excellent quality. It was agreed that the oil from the fresh leaves has the pleasanter aroma, but it was considered that the oil from the dried leaves should prove more useful as it would be more suitable for blending. The Committee were of opinion that there should be a good future for the oil if it can be offered at about 1*s.* 6*d.* per lb., as there is a demand for a cheap oil which would be able to compete with Java citronella oil.

OCIMUM OILS

Six samples of oils derived from various species of *Ocimum* have been examined in recent years. Herbarium specimens of the plants from which the oils were distilled were sent to the Royal Botanic Gardens, Kew, and the results of their identification are included in the following report.

Sample No. 1.—" Ocimum oil No. 6. Distilled February 12, 1934." This was stated to be from a plant known locally as " Toc Maria," which has been identified at Kew as *O. basilicum* Linn. (?). The sample, which was forwarded in March 1934, consisted of a clear, very pale yellow (almost colourless) oil, with an anise-like odour and a pungent taste.

The quantity of oil was too small for detailed examination, but the following physical constants were determined :

Specific gravity at 15·5/15·5° C . .	0·9746
Optical rotation a_D	− 0·4° at 19° C.
Refractive index $n_D 20°$ C . . .	1·5180
Solubility in 80 per cent alcohol at 15·5° C	Soluble in 4·6 vols with slight opalescence

The odour of the oil appeared to be principally due to the presence of methylchavicole (estragol).

The oil was submitted to a firm of essential oil distillers in London, who furnished the following observations :

> " The odour is very fresh but very delicate, and the oil should be useful for cosmetics, such as tooth pastes, high-class soaps and perfumes for shampoos, etc."

The odour of the oil is attractive, though not so fine as that of sweet basil oil, to which it shows some resemblance.

Sample No. 2.—" Ocimum oil No. 6. Yield 3·5 litres per ton. Distilled June 21, 1934." This sample, forwarded in June 1934, was also stated to be obtained from the plant known locally as " Toc Maria." It consisted of a clear, very pale yellow oil, with an odour somewhat resembling that of sweet basil oil but not so fine, and rather less pleasant than that of the sample of " Toc Maria " oil dealt with above.

The oil was examined with the following results, which are shown in comparison with those obtained for the previous sample of " Toc Maria " oil from Seychelles and with the figures recorded for commercial sweet basil oils.

—	Present sample	Previous sample from Seychelles	Commercial oils	
			Réunion sweet basil oil	French, German, Algerian and Spanish sweet basil oils
Specific gravity at 15·5°/15·5° C	0·9616	0·9746	0·945 to 0·987	0·904 to 0·930
Optical rotation α_D . .	− 0·64° at 24° C	− 0·4° at 19° C	+ 0·36° to + 12°	− 6° to − 22°
Refractive index n_D20° C .	1·5160	1·5180	1·512 to 1·518	1·481 to 1·495
Acid value . . .	0·2	—	Up to 3	Up to 3·5
Ester value . . .	6·3	—	9 to 22	1 to 15
Solubility in 80 per cent alcohol at 15·5° C . .	Soluble in 6·7 vols	Soluble in 4·6 vols with slight opalescence	Soluble in 1 to 7 vols	Soluble in 1 to 2 vols.

From these results it will be seen that the constants of the present oil resemble those of the first sample. Compared with commercial sweet basil oils its constants more resemble those of the Réunion oil than those of the French, German, Algerian and Spanish kinds.

The results of the examination of these two samples of " Toc Maria " oil indicated that the product would probably be saleable in the United Kingdom. In order to determine its actual value, however, a sample of about 1 lb. would be required for submission to the trade.

Sample No. 3.—" *Ocimum viride* oil. Distilled February 14, 1934. Yield 9 litres to the ton." The Kew determination confirmed the source of this oil as *O. viride* Willd. The sample which was forwarded in March 1934 was a clear, reddish-brown oil. It was found to have the following constants, which are shown in comparison with the range of corresponding figures obtained for previous samples of *Ocimum viride* oil from Seychelles examined at the Imperial Institute.

	Present sample.	Previous samples.
Specific gravity at 15·5/15·5° C.	0·9362	0·903 to 0·942
Optical rotation a_D	+ 1·01° at 19° C.	+ 0·75° to + 3·12°
Refractive index n_D20° C	1·5039	1·495 to 1·501
Phenols (by absorption) *per cent*	48	31 to 62

The phenols in the present oil consisted, as in the earlier cases, almost entirely of thymol.

The oil was submitted to a firm of essential oil distillers in London, who reported that in their opinion the odour was not quite so fragrant as that of Spanish thyme oil, and that for perfumery purposes the oil would not command such a high price as the latter. The residual odour was quite clean, in contrast to that of a sample from the Seychelles examined in 1917 which was reported to have a rather smoky residual odour. The firm considered that the present oil should be useful for the production of thymol.

At the time of the report (June 1934) thyme oil was quoted in London as follows: White thyme oil (25–30 per cent. phenols), 3*s.* 0*d.* per lb.; red thyme oil (50 per cent. phenols), 4*s.* to 4*s.* 3*d.* per lb.

Thymol was then realising the following spot prices in London: synthetic, from 5*s.* 4*d.* per lb. (for small quantities) to 4*s.* 10*d.* per lb. (for large quantities); natural, from 7*s.* 0*d.* per lb. (for small quantities) to 7*s.* 3*d.* per lb. (for large quantities).

Sample No. 4.—" Ocimum oil No. 2." The source of this oil was determined at Kew as *O. americanum* Mill. forma. The sample, forwarded in March 1934, consisted of clear, yellowish-brown oil, which had a pleasant lemon-like odour combined with a slight subsidiary odour somewhat suggestive of tansy. On examination it was found to have the following constants:

Specific gravity at 15·5/15·5° C	0·9181
Optical rotation a_D	− 3·63° at 20° C
Refractive index, n_D20° C	1·4878
Acid value	12·4
Aldehydes and/or ketones (bisulphite method), *per cent.*	71 (by volume)
Aldehydes, as citral (hydroxylamine method), *per cent*	62·3 (by weight)
Acids and phenols (by absorption with caustic potash), *per cent.*	8
Solubility in 70 per cent alcohol at 15·5° C.	Soluble in 2·2 vols. with slight opalescence.

On removing the aldehydes from the oil by the bisulphite method and regenerating them by means of caustic soda solution, they were found to have the characteristic odour of citral. They formed a semi-carbazone, the melting-point of which after fractional crystallisation showed that the aldehydes present in the oil consisted chiefly of citral ; a small proportion of citronellal was probably present.

The residual oil remaining after the removal of the aldehydes gave reactions indicating the presence of about 4 per cent. of a ketone in the original oil. The odour of the residual oil also suggested the presence of myrcene or ocimene.

Owing to the small quantity of oil available no attempt was made to characterise the acids and phenols present, but the foregoing results show that the chief constituent of the present sample was citral. Small amounts of another aldehyde (possibly citronellal) and a ketone are also present, in addition to acids and phenols ; the remainder of the oil apparently consisting of terpenes.

The oil was submitted to a firm of essential oil distillers in London, who furnished the following observations :

> "This is similar to *Ocimum pilosum* oil, and has a lemongrass odour. It is a clean odour, but not so fine as pure verbena oil. We do not think it would have a very good sale in this country."

The composition of this oil differs entirely from that recorded by previous observers for the oil of *O. americanum* (= *O. canum* Sims). Glichitch and Naves (*Chim. et Indust.*, 1933, **29**, 1029–1033) showed from the results of earlier workers and of their own investigations that two races of *O. canum* exist, which apparently cannot be distinguished morphologically, but which yield different kinds of oil. Oils from Mayotte, Kenya, Comoro Islands and Antibes (Alpes-Maritimes) have been found to contain dextro-camphor and no trace of methyl cinnamate, whilst others from the Comoros, Madagascar and Ubanghi-Chari have given the reverse results, containing methyl cinnamate and no camphor. The results of the examination of the present sample from the Seychelles suggests the existence of yet another form of the species, which yields an oil of which the chief constituent is citral.

It is of interest to note that this oil closely resembles one stated to have been derived from *O. pilosum* Roxb., which was examined in 1914 by K. Bhaduri (*Journ. Amer. Chem. Soc.*, 1914, **36**, 1772) and found to have an odour resembling that of lemongrass oil.

Sample No. 5.—" Ocimum oil No. 4." This sample was forwarded in April 1934. The plant yielding it was identified at Kew as *Ocimum sanctum* Linn.

The sample consisted of a clear, pale yellowish-brown oil, which was found to have the following constants :

Specific gravity at 15·5/15·5° C. . .	0·9840
Optical rotation a_D	− 29·37° at 20° C.
Refractive index $n_{D}20°$ C . . .	1·5210
Phenols (by absorption) . . *per cent.*	33

The phenolic portion of the oil was found to consist almost entirely of eugenol.

The oil had a rather pleasant odour resembling that of samples of oil described as *O. gratissimum* received from Seychelles in 1917 and 1918, and its constituents are probably the same. These earlier samples contained 62 and 55 per cent. of eugenol respectively, and further detailed examination showed that the remainder consisted mainly of linalool, the terpene ocimene, and small proportions of linalyl acetate and methylchavicole.

This oil contains too little eugenol to be of value as a commercial source of this constituent, and it is doubtful whether it would find a ready market in the United Kingdom, but in order to form a definite opinion on this point it was suggested that it might be worth while to forward a further quantity for submission to the trade. It may be mentioned that a firm of essential oil distillers who were consulted concerning the value of the Seychelles *O. gratissimum* oil examined in 1917 did not consider it to have a sufficiently pleasant odour to be of use in perfumery, and could not suggest any other purpose for which it might be employed.

The identification of the plant yielding this oil as *O. sanctum* Linn. is of some interest as it suggests that this species must be added to the list of Ocimum plants which yield different types of oil. Bacon (*Philippine Journal of Science,* 1910, **5**, A, 261) reported that the oil of *O. sanctum* resembles that of *O. basilicum* and contains 50 to 60 per cent. of estragol (methylchavicole). Brooks (*ibid.*, 1911, **6**, A, 345) confirms the statement that the latter is the chief constituent of the Philippine oil and records also the presence of cineole and linalool. In the present sample from the Seychelles eugenol is the chief constituent.

Sample No. 6.—" Ocimum oil No. 3. Yield 6·55 litres per ton. Distilled May 30, 1934." The species from which this oil was obtained would not be determined from the material submitted to Kew. It consisted of oil which on receipt was turbid owing to the presence of moisture, but after filtration through paper was clear and of orange-brown colour. The oil had a fairly pleasant odour, somewhat similar to that of spike lavender oil.

The oil was examined with the following results :

Specific gravity at 15·5°/15·5° C	0·9385
Optical rotation α_D	− 9·93° at 24° C.
Refractive index $n_D 20°$ C	1·4871
Acid value	6·5
Ester value	1·2
Ester value after acetylation	175·7
Equivalent to "total acetylisable constituents" (expressed as $C_{10}H_{18}O$) . . . . . *per cent.*	55·6
Apparent cineole content (by ortho cresol method) *per cent.*	17·7
Solubility in 70 per cent. alcohol at 15·5° C. . . .	Soluble in 1·8 vols.

Although the chemical composition of the oil was not determined owing to the small quantity available, it would appear that the pleasant odour of the oil was due principally to the presence of a considerable amount of linalool, modified by a small quantity of cineole. Although the odour somewhat resembled that of spike lavender oil, the present sample of Ocimum oil contained considerably more alcohols than the latter ; thus, Spanish spike oil is recorded as containing 30 to 44 per cent. of alcohols (expressed as borneol) and French spike oil from 30 to 37 per cent., whereas the ester value after acetylation of the present sample corresponded to 55·6 per cent. of alcohols. Further, the alcohols in the present oil consisted largely of linalool, which is not quantitatively acetylated, and the amount of alcohols actually present was thus probably still higher.

The oil was submitted to a firm of essential oil distillers in London who furnished the following observations :

> " We have examined the sample of Ocimum oil No. 3, and our laboratory report as follows : The odour of this oil is somewhat similar to that of spike lavender but not so pronounced in cineole. It would blend nicely with French lavender oil in compounding soap perfumes. The odour is rather too crude for it to be used in fine quality perfumes."

It is possible that oil of the quality of the present sample would be marketable as a substitute for spike lavender oil, the Spanish variety of which was then quoted at 5*s*. 9*d*. per lb. in London, landed terms (September 1034).

If the yield of " 6·55 litres per ton " (stated on the label attached to the sample), which is equivalent to about 0·6 per cent., is obtained by the distillation of the whole plant, it compares very favourably with that of spike lavender (recorded as ranging from 0·5 to 1 per cent.) which is distilled from the inflorescence only, since the quantity of the Ocimum plant obtainable would obviously be much greater than that of the spike lavender flowers from an equal area of cultivated plants.

CINNAMON ROOT-BARK OIL

The sample of oil which is the subject of this report was forwarded in December 1933. It was stated to consist of oil distilled from the bark of roots obtained from cinnamon bushes, 25 years old, which had been cropped several times for leaves. It was mentioned that an approximate yield of 10 litres per ton of material had been obtained.

The sample consisted of a clear, pale yellowish-brown oil, the odour of which was characteristic of ordinary cinnamon bark oil but was weak and lacking in fragrance.

The oil was found to have the following constants, which are shown in comparison with the range of figures obtained for cinnamon bark oils distilled in Seychelles and previously examined at the Imperial Institute ; and also with the requirements of the British Pharmacopœia (1932) for cinnamon bark oil :

	Present sample.	Previous samples of Seychelles cinnamon bark oils.	British Pharmacopœia figures.
Specific gravity at 15·5°/15·5° C. . . .	0·9811	0·942 to 0·990	1·000 to 1·030
Optical rotation a_D .	+8·45°	− 4·05 to − 8·25°	0° to − 2°
Refractive index $n_D 20°$ C.	1·5317	1·5160 to 1·5465	1·562 to 1·582
Aldehydes (as cinnamic aldehyde) . *per cent.*	36	19 to 37	50 to 65
Phenols (as eugenol) . *per cent.*	5	4 to 11 5	—
Solubility in 70 per cent alcohol at 15·5° C .	Insoluble.	Insoluble.	Soluble in 3 vols.

Cinnamon root-bark oil has been stated to contain camphor as one of its principal constituents, but the odour of the present sample was only slightly camphoraceous. No detailed examination of the oil for camphor was possible with the small quantity available. In composition the oil more resembled a low-grade cinnamon oil distilled from stem bark.

The results of the investigation show that this sample of root-bark oil was much below the standard of quality required by the British Pharmacopœia for the stem-bark oil.

This oil was of low quality, containing only 36 per cent. of cinnamic aldehyde. It could not be employed in the United Kingdom for pharmaceutical purposes, but might find an outlet in soap perfumery if it could be offered at a comparatively low price.

The yield of oil stated to have been obtained from the root-bark furnishing the present sample was nearly 1 per cent., which in view of the character of the material employed may be regarded as fairly satisfactory.

PATCHOULI OIL

A sample of patchouli oil was forwarded in May 1933. It was stated to have been distilled from plants which had been introduced into Seychelles from Ceylon as representing the typical Singapore variety.

The sample, consisting of a clear yellowish-brown oil, was found to have the following constants, which are shown in comparison with the corresponding figures for three samples of patchouli oil from Seychelles examined previously at the Imperial Institute, and with those recorded for Singapore and Java oils :

—	Present sample	Previous Seychelles patchouli oils			Recorded figures for patchouli oil.	
		No 1	No 2	No 3	Singapore	Java.
Specific gravity at 15·5/15·5° C . . .	0·9368	0·9703	0·9635	0·9572	0·960 to 0·980	0·925 to 0·935
Optical rotation α_D .	− 4·48° at 21° C	− 55·6° at 22° C	− 50·3° at 22° C	− 46·6° at 22° C	− 47° to − 61°	+ 3·25° to −32·28°
Refractive index n_D20° C	1·5033	1·5096	1·5089	1·5082	1·508 to 1·512	1·5000 to 1·5080
Solubility in 90 per cent alcohol at 15·5° C	Soluble in 6·1 vols	Soluble in 7 vols	Soluble in 8 vols	Insoluble even in 11 vols	Mostly soluble in 5 to 8 vols	Soluble in 6 to 8 vols

These results show that, except as regards solubility in alcohol, the constants of the present oil differ markedly from those of Singapore patchouli oil, and also from those of the last three patchouli oils from Seychelles examined at the Imperial Institute; they are, however, generally similar to the recorded figures for Java patchouli oil.

The odour of the oil was not very strong, and was distinct from that of any of the three oils from Seychelles referred to above.

The oil was submitted to (*a*) and (*b*) essential oil distillers and (*c*) importers in London, who furnished the following reports respectively:

(*a*) " The sample has been examined in our laboratory and we find that the specific gravity, refractive index and optical rotation are all very much lower than those of ordinary normal Singapore or Seychelles oils. The solubility is good and is more in line with Singapore oil. The odour is clean and free from the usual birch-tar smell of Seychelles oil, but not so powerful.

" The better solubility and the removal of the birch-tar odour are satisfactory, but these improvements do not balance the other differences. We are afraid, therefore, that more work will have to be done to produce an oil that will be acceptable on the market."

(*b*) " Our figures agree with your own, but, as you are aware, these do not represent the characters of true patchouli oil, particularly the low specific gravity and rotation. The odour compares badly with ordinary imported oils, so that one cannot help thinking that the material used for distillation could not have been of the correct quality. The value of the oil would be very problematical."

(*c*) " This oil has not such a pleasant or lasting odour as a sample of English-distilled patchouli oil (from Ceylon leaves), but is very similar in odour to a recent purchase of foreign oil. The fixative properties of the oil do not seem to be as good as an average sample, and we would hesitate to recommend the use of this oil for perfumery."

From the foregoing results it will be seen that the constants of this oil differ considerably from those of Singapore patchouli oil derived from *Pogostemon patchouli* Pellet, but are generally similar to those of Java oil which is said to be distilled from *P. Heyneanus* Benth., a species indigenous to India. It would appear that if the plants represent the Singapore variety of patchouli a great change in the character of the oil has been induced by the local conditions in Seychelles.

The trade reports on the oil are unfavourable and it seems unlikely that it will be worth while to extend the cultivation of the plants in question It was pointed out, however, that before coming to a final decision on this point, it would be desirable to prepare and forward a further sample of the oil for examination in comparison with the results recorded above.

In accordance with this suggestion a small sample (¾ oz.) of oil distilled from the same plants was forwarded in September 1933. It consisted of a clear, pale yellowish-brown oil and was found to have the following constants:

Specific gravity at 15·5/15·5° C.	0·9333
Optical rotation α_D at 19° C.	− 3·25°
Refractive index $n_D 20°$ C.	1·5030
Solubility in 90 per cent. alcohol at 15·5° C.	Soluble in 6·4 vols.

It will be seen that the characters of this second sample of patchouli oil were similar to those of the previous sample, and the results confirm the opinion expressed in the previous report that it would appear undesirable to encourage further cultivation of the plants from which the oil was produced.

AGAVE AMANIENSIS FIBRE FROM TANGANYIKA—II

IN a previous number of this BULLETIN (1933, **31,** 1) a report was published on the fibre of a new kind of Agave, which was found growing at the East African Agricultural Research Station, Amani. The fibre proved to be of very promising quality, superior to good No. 1 African Sisal. Since then cordage trials with the fibre have been carried out, the results of which are given in the following pages.

The plants in question were grown at Amani under the name *Agave Lespinassei*, but as they did not agree with the published description of that species, Mr. W. Nowell, Director of the Station, forwarded specimens to Professor Trelease, the recognised authority on the genus. He considered it to be an undescribed form belonging to the *Zapupe* group. A description of the plant, under the name *Agave amaniensis* Trelease et Nowell, together with an account by Mr. Nowell of its history and properties, has been published in the *Kew Bulletin* (No. 10, 1933, pp. 465–467).

The material employed in the investigation, consisting of about 5 cwts. of fibre, was forwarded to Mr. G. C. Hawkins (Messrs. Hawkins & Tipson Ltd., London), a member of the Imperial Institute's Advisory Committee on Vegetable Fibres, by Mr. L. R. Doughty, Geneticist to the East African Agricultural Research Station, with a letter dated July 16, 1934. Mr. Doughty made the following observation regarding the material :

" The bale is a mixture of fibres from a second and third cut ; the decortication has been carried out on a Corona machine. The nature of the leaf and the arrangement of fibre in the leaf do not lend themselves to good decortication on these machines when set for Sisal, so that the cleaning is not entirely satisfactory. Given a sufficient quantity of leaf to test various settings of the drums, no doubt a considerable improvement in decortication could be obtained.

" The plant is of considerable interest as it produces a longer, heavier leaf than Sisal and is quicker growing ; the percentage of fibre extracted is approximately the same as that of Sisal, but the out-turn of fibre per acre appears to be considerably greater."

Manufacturers' Reports on the Fibre

(1) The following report on the fibre was furnished by Mr. G. C. Hawkins :

1. *Length.*—Uniformly long, averaging about 4 ft. 6 in., and all over 4 ft.
2. *Colour.* - Creamy white, averaging good No. 1 East African Sisal, but close inspection reveals rather wide variation from dead white (Java type) to sandy or sunburned.
3. *Texture.*—Very soft throughout, with scarcely any increase in harshness towards the butt ends.
4. *Size.* - Mostly a fine fibre, but contains a rather too high percentage of wide strips.
5. *Strength.*- Should be well up to normal, as far as can be judged by hand tests.
6. *Appearance.*—Clean straight fibre, with no tousling in spite of its softness ; healthy, glossy finish.
7. *Baling.*— Neatly packed, laid parallel, no " matting " of fibre.

In forwarding this report to the Imperial Institute, Mr. Hawkins made the following observations :

" I gather from Mr. Nutman that the leaves were cut and sent away for decortication in the usual manner, but that if a dead-white colour were desired machine-drying could be employed. I understand also that the Amaniensis leaf, owing to its structure, presents difficulties in decortication that may account for the variation in colour to some extent.

" The best feature of this fibre is its softness and pliability, especially at the butt ends where harshness is to be expected. This should make for better spinning and should eliminate the harsh ' whiskery ' finish which is apt to spoil Sisal ropes, cords and yarns.

" The fibre would be improved with more thorough preparation to remove the excessive strippiness. But no attempt should be made to produce a softer fibre, or to adopt softening processes (except possibly for special non-cordage uses). This might lead to a weakening and breaking up of the fibres, and would result in tousling and 'birds'-nests' in spinning. The present texture is ideal—at any rate for rope, heavy cords and binder twine.

"Turning to the financial aspect, I am afraid that a premium could not be expected on the fibre as it is, although I am confident that it would always find a ready market in preference to most other East African Sisals. In times of medium or high prices it might fetch a small premium of 5*s.* to 10*s.* a ton, but this is by no means a certainty. Were it machine-dried it should command a good premium, because it is slightly softer and finer (except for the strips) than Java Sisal, and has ideal spinning length."

(2) The bale of fibre was inspected at the works of Messrs. Hawkins & Tipson, by Mr. C. Stairs Duffus, of the London Spinning Co., Ltd., who reported on it as follows:

"The fibre was of excellent length and strength, and finer and softer than the average East African Sisal. If the fibre had been machine-washed and dried it would have been, I consider, a very excellent rival of Java Sisal. It is difficult to say to what fineness this fibre could be spun without passing it over the machines, as I do not know to what extent it would become finer and more supple during the manufacturing process. I feel sure, however, that it would spin admirably into yarn of, say, 1½-lea and possibly even 2-lea, that is to say, up to 600 yards to the lb.

"Should it be possible for ½ ton of this fibre to be sent to an estate with a machine-drying installation, I would very much like to buy it at a reasonable current market price and experiment with it. I could then advise you further.

"I certainly consider *Agave amaniensis* to have superior spinning properties to ordinary Sisal."

Technical Trials

1. *Messrs. Hawkins & Tipson's Investigations.*—Messrs. Hawkins & Tipson manufactured from the *Agave*

amaniensis fibre 120 fathoms of rope, nominally 3 in. in girth, 7 lb. of 3-ply box cord and 2½ lb. of 3-ply fine twine. They also made for comparison corresponding products (with the exception of the fine twine) from No. 1 East African Sisal. The firm carried out tests on the ropes at their works and furnished the following summary of the results obtained :

Strength Tests

	A. amaniensis	No. 1 East African Sisal
Breaking strain of yarn ex-mill		
Actual . .	259 lb. (av. of 40)	211 lb. (av. of 40)
At correct weight .	243 lb.	209 lb.
Breaking strain of yarn ex fag-end	255 (1 strand)	201 (1 strand)
Breaking strain of rope[1] . .	98 cwts.	84 cwts.
Breaking strain of rope, per cent. of total yarns . .	65⅜	61¾

[1] *Determinations carried out at the Imperial Institute (see next page).*

Soaking Tests

	A. amaniensis		No. 1 East African Sisal	
	Short samples	Long samples	Short samples	Long samples
Time rope floats . .	30 secs.	0 secs.	0 secs.	0 secs.
Size, original . . .	3¼ in.	3¼ in.	3 in.	3 in.
,, swollen . .	3½ ,,	3½ ,,	3¼ ,,	3¼ ,,
,, increase in . .	¼ ,,	¼ ,,	¼ ,,	¼ ,,
Weight, original . .	3½ oz.	7¾ oz.	3 oz.	7¼ oz.
,, saturated .	4⅝ ,,	10½ ,,	4 ,,	9½ ,,
,, increase in .	1⅛ ,,	2¾ ,,	1 ,,	2¼ ,,
,, increase *per cent.*	32.1	35.5	33.3	31.0

2. *Imperial Institute Investigation.*—The labels and weights of the rope supplied to the Imperial Institute were as follows :

(1) " 120 fathoms 3-in. rope, *Agave amaniensis.* Weight, 1 cwt. 3 qrs. 12 lb."

(2) " 120 fathoms 3-in. rope, No. 1 East African Sisal. Weight, 1 cwt. 3 qrs. 4 lb."

The breaking loads of the ropes were determined by the usual method adopted at the Imperial Institute, and the following results were obtained :

	Agave amaniensis rope. *lb*	No. 1 East African Sisal rope. *lb.*
Test No 1	11,020	8,980
,, No 2	11,150	9,520
,, No 3	11,330	9,700
,, No 4	10,670	9,740
,, No 5	11,030	9,140
,, No 6	10,030	9,320
Maximum breaking load	11,330	9,740
Minimum ,, ,,	10,670	8,980
Maximum variation	660	760
Average breaking load	11,022 (or 98·4 cwts.)	9,400 (or 84·0 cwts.)

It will be seen from Messrs. Hawkins & Tipson's report that the average girths of the two ropes differed by about ¼ in. In this connection it is interesting to observe that in the British Government Departmental Specifications for Manila ropes (No. T.G. 30) the following figures are given for the minimum breaking strength (in lb.) of ropes of girths approximating to those of the ropes dealt with in the present report and differing from one another by the same amount (viz. ¼ in.):

Girth *in*	T G 30 specification. Breaking load *lb*	Present figures for comparison. Breaking load *lb*
3	8,960	9,400 (Sisal)
3¼	10,640	11,022 (*A amaniensis*)

Judging from these figures it would appear that the greater strength of the *Agave amaniensis* rope might have been expected, owing to its greater girth. It must be pointed out, however, that the weight of fibre per unit length of rope was the same in each case. It is thus evident that ropes of *A. amaniensis* and Sisal of *equal girth* should be of about the same strength. It follows that a smaller weight of *A. amaniensis* fibre would be required than of Sisal for rope of the same size, and the former fibre would therefore be more economical; it would also be somewhat lighter to handle.

Remarks

The results of the present investigation were placed before the Imperial Institute Advisory Committee on Vegetable Fibres, who regarded them as very promising and considered that the production of *Agave amaniensis* fibre in East Africa might usefully be extended, as the material, if well prepared, should be readily saleable.

Specimens of the ropes, box-cord and twine, made by Messrs. Hawkins & Tipson in the course of their trials, are available for inspection at the Imperial Institute.

ARTICLE

THE ESSENTIAL OIL INDUSTRY OF SEYCHELLES

By W. Holdsworth Haines

The following article is a summary, prepared by Mr. Holdsworth Haines, of a report submitted by him to the Government of the Seychelles and is printed with the kind permission of the Governor of the Colony. Mr. Holdsworth Haines was specially appointed by the Colonial Office to report on the position of the industry, and his investigations covered a period of twelve months during 1932–33.

Introduction

As far as possible, the work has been conducted, not only with a view to obtaining strictly scientific data, but with the object of securing information of practical value at the same time, thereby economising time and material.

During my stay, a number of experimental distillations were carried out at three large private distilleries, and with a few exceptions I visited every distillery in the Colony. During most of these excursions the Assistant Director of Agriculture gave me much valuable assistance. Many of the distillers came to see me at my distillery, some visiting me several times. Such visits were welcome, and most useful from the instructional point of view. On these occasions I have always given local distillers facts and figures useful to the practical man, and results experimental only I have considered it prudent to withhold.

Several meetings of the Planters' Association were attended by me.

LOCAL DISTILLERIES

Of the eighty-seven distilleries in the Islands, there are four devoted solely to the distillation of patchouli, sixty-seven to cinnamon leaf, and sixteen where both patchouli and cinnamon leaf are distilled. Twelve of the distilleries possess steam boilers, one works at atmospheric pressure and the remainder are of the under-fired type and are of local or European construction. Under normal conditions, the efficiency of the stills is in the order above named, but some of the under-fired stills are being used more effectively than the pressure type, which is normally the more efficient. The majority of the stills are under-sized for the speed at which they are run, and whilst it is not suggested that this speed should be lessened, there are certain features of the stills which could with advantage be altered.

Still Bodies.—In general, the ratio of height to diameter is roughly one to one, a proportion which does not permit of adequate contact between the leafy material and the steam. Efficiency would be improved if the ratio of height to diameter were two or two and a half to one. This could be effected in many cases by the introduction of " belts " in order that the heights of the still bodies be increased. The capacities of the stills would thereby be increased and a longer time for distillation with a given quantity of water will be necessary. Efficiency would, however, be increased. For some years local efforts have been made to improve the efficiency of distillations by the introduction of inverted " V " grids, but the results of these efforts have not been satisfactory as these grids lower efficiency by shortening the time of contact between the steam and the leaves.

Condensers.—All the condensers, even those of European make, are undersized. Allowance has not yet been made for the differences in average temperatures of the cooling water in Europe and the Seychelles. With cooling water at an average of 30° C., cooling surfaces should be at least 33⅓ per cent. in excess of that usually provided in Europe, and there would be no objection to their being increased to even 50 per cent. over the European standards. Vats holding condenser coils should also be provided for the large entrances and exits for the cooling water. If this is done, the temperatures of the water in the vats could be maintained within a degree or so of the temperature of the water of supply, and such an arrangement should be easily possible in the Seychelles as there is an adequate water supply available.

Separators.—The common types of separators used consist generally of small metal cylinders averaging from about 15 centimetres to 23 centimetres in diameter, and from ½ to 1 metre in length. They are, for the most part, locally constructed and are so made that easy and thorough cleaning is difficult. This is a definite drawback, as cleanliness is essential in the working of an essential oil distillery. The diameters of the separators should be increased up to 50 centimetres in order that the rate of flow of the distillate through them may be reduced. The temperature of the distillate flowing from the condenser is naturally higher than would be experienced in Europe, and it will be appreciated that with a liquor containing oil the rate of flow through the separator should be lessened when temperatures are increased.

Heating.—The abandonment of the under-fired type of still in favour of boiler units is recommended. In the latter, fuel is consumed to much greater advantage than in the case of open grates. The majority of the existing under-fired stills are provided with large grates with the fire immediately under the still. The chimney is usually directly behind the still and the greater part of the heat is in consequence carried to the back of or beyond the still. There is in consequence a great loss of efficiency in fuel consumption which accounts for the high costs and large fuel consumption by this type of still. It was observed that the greatest heat from the fire appeared to be in the chimney throat or actually in the chimney itself. In a few cases, chimneys have been provided with dampers, but the use of these dampers for preventing excessive loss of heat appeared to be unknown.

FUEL

Wood is being used less as a distillery fuel and is being replaced by vegetable waste materials such as coconut husks and batons. This is due to shortage of wood by the depletion of the hillside forest cover, and the position will become increasingly difficult unless re-afforestation is undertaken. The general opinion is that the use of coconut husks and batons as fuel results in a smaller out-turn of oil than when wood is used. These lower yields are in fact chiefly caused by inattention on the part of the stokers, as with quick-burning material the fire has to be fed much more frequently than when wood is used. With wood, it is possible to provide for a steady run for a considerable period, but in order to accomplish the same with quick-burning materials much more frequent stoking is required if regularity is to be maintained.

The fuel supply is of as great importance to the industry as the supply of oil-bearing raw materials. It accounts for approximately 50 per cent. of the cost in even the most efficient distilleries. Wood in favoured locations costs Rs. 1.50 to Rs. 2 per cord—the price of the cutting—but when bought in the market it costs between Rs. 6 and Rs. 10 per cord.

The following table shows the comparative costs of fuel in forty-two distilleries from which data were procured.

Comparative Cost of Fuel for Cinnamon Leaf Oil

Number of distilleries	Fuel cost per ton of leaves.	Cost of fuel per litre of oil
3	Rs. 2	Rs. 0.30
2	Rs. 4	Rs. 0.60
9	Rs. 6	Rs. 0.80
7	Rs. 8	Rs. 1.10
12	Rs. 10	Rs. 1.40
6	Rs. 12	Rs. 1 70
3	Rs. 15 to Rs. 20	Rs. 2.00 to Rs. 3 00

Distilleries which are still burning wood as fuel usually use it green. In many cases, wood which had been cut the previous day is used. This seemed to be a wasteful process and experimental work was, therefore, done in order to ascertain if improvements could be effected.

The following table gives the weight of fresh wood per cord; together with the relative amounts of water per cord, they will evaporate at a working pressure of 40 lb. It should be emphasised that these figures are applicable only to the boiler in which the experiments were conducted. The woods can in no way be compared with the consumption of wood in any other boiler, except in a relative fashion.

—	Moisture on air-drying	Weight per cord	Litres of water per cord of fresh wood	Litres of water per cord with air dried wood	Litres of water per cord of fresh wood in lagged boiler.
	per cent	*kilos*			
Albizzia	52	623	399	470	483
Cashew	46	700	462	534	571
Rubber	38	934	523	653	687
Acacia	28	584	700	803	895
Cedar (*Casuarina equisetifolia*)	28	664	946	1,014	1,024
Pruen	27	552	463	—	523
Cinnamon ex bark preparation	26	525	500	560	615
Gum copal	26	838	570	880	905
Agatte	25	504	660	790	815
Capucin (*Nathea seychellana*)	—	794	1,280	—	1,491
Coconut shell	—	1,000	1,010	1,000	1,760
Coconut husks	—	433 (1,000 husks)	303	—	483 (per 1,000)

From the foregoing table, the advantages of using air-dried fuel will be readily recognised, a saving of one cord in four or five being effected by this alone. Although the table only shows the additional evaporation of water from fresh wood with lagging, it can easily be appreciated that a double advantage is to be gained by using air-dried fuel in an efficiently lagged boiler.

The cost of lagging material is approximately £27 per ton plus freight, to which must be added the cost of application, which would be small. The covering power of a ton of lagging material is approximately 2,400 sq. ft. Local labourers experienced no difficulty in applying the lagging to the boiler used in this investigation, and it must be remarked that the result was a good workmanlike job.

Considering the already depleted supplies of wood, it is urged that all wood used as fuel should be dried before use, and that all steam-heated surfaces should be "lagged."

CINNAMON

This tree grows wild, and is mainly confined to the higher altitudes. Tracts of country formerly well covered with cinnamon are now largely depleted, and it is generally recognised that this has been brought about by over-cropping. If the industry is to continue some degree of conservation will become necessary in the not far distant future. At intervals, cinnamon receives a so-called pruning, which consists of cutting the bushes down to within 6 to 12 in. of the ground. Much better results would be secured if this pruning were done at ground level, and the cut surfaces covered with earth. This system of coppicing has been repeatedly suggested by the Imperial Institute, and one planter who has adopted this system found that a large increase of straight shoots were secured.

Some cinnamon is also grown as an inter-crop in the coconut plantations, but from such areas the oil yields are low.

Harvesting Leaves.—The collection of leaves is carried out by men and women under a " contract " system whereby they are paid per ton of leaves collected and transported to the distillery. The daily quota is approximately 40 kilos. for a woman and 50 kilos. for a man, and the average price paid by a proprietor to collectors of leaves from lands owned by himself is approximately Rs. 4.00 per ton. In addition foremen are employed. These supervise the collectors and are paid a monthly wage of approximately Rs. 17, which equals about R. 1.00 per ton of leaves. The transport of raw material is invariably included with collection in the " contract " prices agreed upon.

A considerable number of experimental distillations were carried out and the following conclusions can be drawn from the data which were secured :

(1) The maturity of cinnamon leaves is not attained in twelve months' growth and the necessary time appears to be between eighteen months and two years with trees growing under good conditions.

(2) Seasonal variation of the oil content in the leaves does not appear to occur during the first year's growth, but during the second year's growth a maximum is reached in the two months prior to the " repoussé " or growth which takes place in May and September.

(3) Of the two types of distillation, steam and water, the steam method is superior.

(4) Material used for distillation should be as fresh as possible.

(5) The rate of distillation is largely immaterial if efficient condensation is provided.

Cinnamon Leaf Oil.—The exports of cinnamon leaf oil during 1932 amounted to 49,679.75 kilos. against 54,793 kilos. in 1931. Local prices in 1932 averaged from Rs. 4.50 per litre in January to Rs. 3.00 in April and touched Rs. 4.00 in the last few months of the year. London prices ranged from the equivalent of Rs. 3.29 to Rs. 4.27 per kilo. The following table gives the costs of production of forty-seven distilleries in January 1933.

Number of distilleries	Percentage of total production in Colony	Average production cost per litre
2	4·0	Rs. 1.25 or less
2	0 8	Rs. 1.75 or less
12	24 0	Rs. 2 25 or less
10	18 0	Rs. 2 75 or less
12	29 0	Rs. 3 25 or less
5	8 7	Rs. 3 25
4	2·5	Rs. 3 25 or more

Twenty distilleries were not working, nine had been abandoned and from seven no information was received.

The producer in the Seychelles receives the equivalent of the full London price without deductions for packing, freight and insurance. This appears to be due to the lack of banking facilities in the Seychelles and the local merchants' need for credit in Europe or America. The oil is purchased by these merchants as a method of drafting credit. Co-operative marketing has been discussed, but it is doubtful if this method would be of advantage to the producers, as they receive at the present time values which represent the full London values plus an addition which is equivalent to the charge which would normally be made for banking facilities.

Cinnamon Bark Oil.—Large quantities of cinnamon bark oil were produced in the Seychelles in 1916, but at the present time no such oil is distilled. The oils formerly produced were of low quality and the aldehyde content appears never to have exceeded about 36 per cent.

In 1928 a fairly large distillation of cinnamon bark was carried out by the writer on the Cascade Estate, Mahé This bark yielded 8 litres of oil per ton. The oil had a good odour, an absorption in sodium bisulphite of over

67 per cent. and a specific gravity greater than that of water.

Experimental work was continued during the present investigation and it is estimated that if all the bark of the cinnamon now used as fuel were employed for the distillation of bark oil a production of 3,860 litres should have been possible in 1932 of an export value of Rs. 96,500. The presence of cinnamic aldehyde is greater in the younger than it is in the older growths. Thick corky bark appears to give a light oil and therefore is not suitable. Stems 10 ft. high, with a diameter of 1½ to 2 in. at the base and covered with brown epidermis, give the best results. The bark from such stems should be stripped as quickly as possible after collection and the bark may be dried if necessary, provided that during drying contamination with other materials is prevented and mould growth not permitted to take place.

All apparatus to be used for distillation must be scrupulously clean and the still should be filled as full as possible, the bark being well packed down. Distillation should commence with saturated steam (super-heated steam must not be used) and continued until the distillate is free from oil. The first signs of this is the change in colour of the distillate from milky (i.e. liquor containing oil) to colourless and the final point determined by taste. For a normal bark the amount of liquor from this first operation will be approximately one-and-a-quarter to one-and-a-half times the weight of the bark in process and a vessel or vessels large enough to hold this liquor should be provided. An oil lighter than water separates from the " milky " liquor. This is removed and if the apparatus is clean it will be light yellow in colour. The quantity of light oil from a normal bark should be approximately 2½ to 3 litres per ton.

When this first operation is complete, the spent bark should be removed from the still, which is made ready for the redistillation of the " milky " liquor. This is placed in the now empty still and heating commenced with the closed coil (*serpentin de chauffe*). The distillate will be " milky " as before and from this an oil heavier than water will separate if the cooling and concentration are sufficient. The amount of liquor will be approximately half the amount returned to the still and the total amount of heavy oil obtained should be equal in volume to that of the light oil already separated. If the full quantity of heavy oil is not obtained in the first redistillation, the liquor should be again redistilled. Both heavy and light oils from this same bark are mixed and the final bulked oil should be heavier than water.

Care must be taken that bark alone is distilled when the bark oil is being produced. Leaves must not be included. It is also essential that stills previously used for distilling leaf oil and all vessels similarly used should be thoroughly cleaned before they are employed for bark distillations. Otherwise, the quality of the resultant oil is inferior.

PATCHOULI

This plant is established between the palms in coconut plantations, and by the copious use of spent cinnamon leaf and other manures three crops a year are usually obtained. Experimental investigations indicate that drying the leaves increases the oil content, but does so at the expense of quality. Fermentation of the leaves appears to obviate this to some degree. The experiments showed the decreasing volume of oil per volume of steam used and that the soluble portions of the oil are those which distil towards the end of the distillation, emphasising the importance, if quality is to be considered, of completely exhausting the leaf under process. Furthermore the importance of bulking all the oil from a given distillation must not be overlooked.

Trouble has been experienced from time to time by local distillers by the production of a patchouli oil green in colour. This is due to contamination with copper of an oil with a high acid value, and excessive fermentation of the leaves will produce an oil of a high acid value. The green colour, but not the high acid value, may be removed by the addition of a small quantity of powdered tartaric acid. If the oil is of an excessive brown colour it is likely that iron has been the cause and the brown colour may be removed in a manner similar to that described above in cases of contamination with copper. The colour of patchouli oil distilled under good conditions is a golden yellow to light brown, and a good-coloured oil cannot be produced unless cleanliness is practised. The costs of production are shown in the following table:

Number of distilleries.	Percentage of Colony's production.	Cost per litre.
3	27·5	Rs. 1.24
1	3·4	Rs. 1.60
1	3·4	Rs. 2.00
3	10·0	Between Rs. 2.50–2.90
1	20·0	Between Rs. 6 00–7.00
2	12·0	Rs. 7.00
1	6·8	Rs. 7 50
3	13·0	No records or accounts kept
1	Not working	—
4	Information not forthcoming	—

Forty-four per cent. of the Colony's production of patchouli oil is produced at less than Rs. 3.00 per litre. Prices in 1932 ranged from Rs. 9.00 to 10.00 per litre and the production in that year was 2,424 kilos.

The Seychelles oil under careful distillation does not differ materially from the Singapore oil, but the Department of Agriculture has recently received plants reputed to be the Penang variety of patchouli and the leaves of these plants seemed to be quite distinct from the Seychelles variety. No experimental distillations were possible owing to lack of sufficient material, but it is obvious that such test distillations are necessary in order that the quality of the oil may be tested before the replacement of the local type is recommended. In the event of this introduction showing that a plant suited to local conditions capable of producing a high-quality oil has been obtained, measures should be taken systematically to replace the existing type. In the meantime the correct methods of patchouli growing should be encouraged amongst the small-holding class of peasantry, as the plant grows well under the conditions existing in the Seychelles.

Ordinance 11 of 1932 provides for the grading of patchouli oil and enables the Department of Agriculture to test all consignments exported from the Colony. This will, in course of time, have the effect of restoring the prestige of the Seychelles product. At present consignments are contained in exporters' containers and samples are drawn from each for testing. A system of locked vats of from 50 to 60 gallons' capacity in the Customs warehouse to be hired to exporters might assist the industry, as it would provide a satisfactory system of bulking and permit of one sample being drawn per consignment.

PALMAROSA AND GINGERGRASS

The amount of *Cymbopogon Martini* var. *motia* growing in the Seychelles is small and some confusion exists in the island in regard to its identity. Only a few kilos. of the true palmarosa grass could be secured for experimental distillation and the odour of the oil from the flowering heads was particularly good. The prospects for any distiller who will secure the true palmarosa and take trouble with its distillation appear to be good.

Cymbopogon Martini var. *sofia*, the source of gingergrass oil, is growing in fairly large quantities in different parts of the island of Mahé, and it is possible that its cultivation has been undertaken in error for palmarosa. Experimental distillations were made with this grass and the odour of all the oils secured was definitely that of gingergrass.

LEMONGRASS

Two varieties of this grass are distinguished in the Botanic Gardens as " Red " and " Pink." Experimental distillations were made with three-month-old grass from each kind, as well as with older grass from clumps stated to be *Cymbopogon flexuosus* and *Cymbopogon citratus*. Grass three months old does not yield as highly as the older grass, but in order to secure an oil of high citral content young growth should be used. Yields of 3 to 3½ litres per ton, with a citral content of 85 to 90 per cent., have been secured from grass five to six months old.

VETIVER

A number of experimental distillations were made with vetiver roots. An average yield of three litres per ton of dried roots was obtained. The odour of the oil obtained was extremely fine.

EUCALYPTUS CITRIODORA

Experimental distillations were made. Leaves six to twelve months of age gave yields equal to 16·21 litres of oil per ton and leaves from young growth four months later from the same trees gave yields equal to 16·6 litres of oil per ton. With re-cropping at four-monthly intervals it seems that yields of about 15 litres per ton of leaves might reasonably be expected. Distillation is rapid and simple and presents no difficulties.

This tree could be used for re-afforestation, as it has a considerable value as fuel even if there might be some difficulty in securing a market for the oil. The new Economic Nursery is preparing to meet demands from planters for seedlings of this plant—seed having been imported from South Africa for propagation.

OTHER EUCALYPTI

Distillations were made of fresh leaves of *Eucalyptus falcifolia*. A yield of 10 litres of oil per ton was secured. *Eucalyptus tereticornis* gave a yield of 4·2 litres of oil per ton of leaves and *Eucalyptus alba* a yield of 2·8 litres per ton. Oil from the last species was devoid of cineol-like odour and in the case of the first two the cineol content was low.

MISCELLANEOUS OILS

Distillations were also made of Pimento leaf oil and a yield of 6·8 litres per ton was obtained. Nutmegs yielded a return of 64·3 litres of oil per ton. Cardamoms gave a yield of 51 litres of oil per ton. *Ocimum viride* yielded 3·9 litres per ton and *Ocimum canum* gave a yield of 1·3 litres per ton.

PROSPECT OF CO-OPERATIVE PRODUCTION OF ESSENTIAL OILS IN THE SEYCHELLES

It was expressly desired that the possibilities of establishing a co-operative system of production should be investigated. Some form of co-operation is obviously desirable if the industry is to make progress, but there are many difficulties by reason of the physical nature of the islands to be overcome. In 1931 His Excellency the Governor set up a Committee to study the subject of co-operative marketing, but the scheme proposed would not, in my opinion, have been of benefit to the industry. It would have been preferable to have advanced by degrees. Several groups of neighbouring planters should be formed, and each group should possess a steam-driven plant. At present there are twelve steam distilling units in the Seychelles, but one of these is too small for use as the centre of group distillation. The present Planters' Association should be able to encourage the formation of these co-operative groups, which would be spread fairly evenly throughout the island of Mahé if located around the existing steam distilleries. Local conditions are not suitable for the establishment of a small number of central distilleries. In such distilleries skilled supervision would be required and the continued scientific checking of the raw material supplied would be necessary. Such provision would be impossible to secure. The group system, however, is simply an amalgamation between local enterprises, and the present owners should be able to provide all the supervision that would be required.

Summary of Recommendations

Local Stills

1. The proportions of the still bodies should be altered so that the ratio of height to diameter is as 2–2½ to 1. Additional "belts" can be introduced in existing stills in order to increase height in relationship to diameter.

Condensers

2. The actual cooling surfaces should be enlarged and larger cooling-water entrances and exits to the vats holding condenser coils should be provided.

Separators

3. The diameter of the separators should be increased to not less than 50 centimetres.

Heating

4. The under-fired type of still should be abandoned in favour of boiler units.

Fuel

5. The use of fresh green wood should be abandoned. Better results are secured from dried wood.

Cinnamon Leaves

6. Older leaves should be used for distillation and, having regard to the disappearance of cinnamon trees from many parts of the Colony, the introduction of a close season is suggested.

Cinnamon Leaf Oil

7. Distilleries provided with steam generators could improve their production by installing collecting vats of a capacity sufficient to hold a day's production. The mother liquor should be run into such vats and allowed to stand for twenty-four hours without disturbance. The vats should each be supplied with two cocks, one situated at the bottom and the other 1 ft. from the bottom. Through the upper tap the large bulk of the liquor when freed from oil can be speedily run away, whilst from the bottom the much smaller bulk of liquor consisting mostly of oil can be removed. An increase of an additional litre of oil per ton of leaves can be secured by the adoption of the above method.

Cinnamon Bark Oil

8. Bark from stems which are approximately 2 in. in diameter gives the best yields and care must be taken to prevent mould. The oils should be dried by treatment with powdered anhydrous sodium sulphate before packing, and in order to maintain a good colour aluminium or glass containers should be used.

Patchouli

9. Economy can be effected by collecting whole plants, which can be tied in bundles and hung up for drying prior to distillation. Fermentation does not appear to be necessary. Distillation should be done with dry saturated steam. After distillation the oil should be bulked, and prior to filtration it should be treated with powdered anhydrous sodium sulphate to remove the water dissolved in it. The oil should be packed in aluminium, well-tinned iron or glass containers.

Palmarosa

10. The cultivation of this grass should be of great value, as it could be used on steep hillsides to check soil erosion. The cultivation of only true palmarosa should be undertaken and gingergrass should be eliminated.

Cardamoms

11. Experimental propagation of cardamoms is worthy of consideration.

Co-operative Organisation

12. A group system of distilleries is recommended, and the existing twelve steam units could be used as centres for this suggested group organisation.

NOTES

The Experimental Cultivation of Tung Trees in Australia.—In an article entitled "The Experimental Cultivation of Tung Trees in the Empire," which was published in this BULLETIN (1932, **30**, 24), reference was made to the results of attempts to grow this tree in Australia. Further information dealing with the progress of these trials is given in the third edition of *Bulletin No.* 12 of the Technological Museum, Sydney, New South Wales, which has been recently issued.

In New South Wales, besides the two plantations at Pennant Hills, a number of experimental groves varying in extent from one to fifty acres have been established in the surrounding district, known as the Hills District. Trees have also been planted by the Forestry Commission of New South Wales and the Comptroller-General of Prisons in various localities to determine the most suitable situations for the successful cultivation of *Aleurites Fordii* in that State. The proposed extensive plantation at Bundanoon has now been established by Tung Oil (Australia), Ltd. Considerable progress has also been made with the experimental groves in the Northern Rivers District.

In Queensland, on an estate of 60 acres near the Johnstone River, Innisfail District, about 7,500 trees have been planted by Queensland Forests, Ltd., on rich volcanic and alluvial soils. These plantations, which have been established for the purpose of demonstrating the possibility of producing multi-cluster seed of *A. Fordii* on a commercial scale, are situated about seven miles from the Pacific coast at an altitude of approximately 400 ft. The rainfall averages 145 in. annually and the temperature ranges from 45 to 105° F. Samples of seed grown on these plantations have been received at the Imperial Institute and found to contain a normal percentage of oil of good quality.

In addition to details of the cultivation experiments made during the last ten years in Australia the bulletin furnishes recommendations based on the experience thus gained for the establishment of nurseries.

In summarising the results obtained from the experimental trials so far conducted the authors of the bulletin state that "evidence is accumulating that the tree, *Aleurites Fordii*, will thrive in certain localities, present indications pointing to the coastal belt of the east coast of Australia from Sydney northwards as being the most suitable. It has also been proved beyond doubt that the quality of the oil from Australian-grown trees is at least equal, if not superior, to that obtained from China." They add further : "It is our opinion that the cultivation of the Tung Oil Tree in Australia is likely to prove a very successful side-line for orchardists and poultry farmers."

The Cultivation of Tung Trees in the United States of America.—Economic and commercial factors in the development of a domestic Tung oil industry in the United States are discussed by C. C. Concannon in a recent *Circular* (No. 465) of the Scientific Section of the National Paint, Varnish and Lacquer Association, Inc. According to this author the American Tung Oil Corporation has admirably served the purpose, for which it was established in 1923, of demonstrating the possibility of producing Tung oil in the United States. The experience gained has been of great value in connection with the cultivation of Tung trees in America and elsewhere, and seed and seedlings from the Corporation's plantations have been largely used for experimental trials in many countries.

Florida was originally considered to be the natural American habitat of the Tung tree, but subsequently it was found that the tree could be grown successfully elsewhere in the United States, as is indicated by the following recent figures of the acreages under Tung trees in various States : Florida 16,100, Georgia 3,500, Alabama 555, Louisiana 2,500, Mississippi 21,000 and Texas 400. The southern and northern limits of the area suitable for these trees depend principally on temperature considerations. Soil and drainage requirements largely determine the localities within this area which could successfully foster commercial plantations.

Among the difficulties that have been encountered in the course of the cultivation of Tung trees in the United States are the occasionally adverse weather conditions. Exceptional frosts and drought two seasons ago caused a set-back to the industry throughout the southern States, but the author does not consider that injurious frosts will occur frequently enough to interfere with the development of Tung oil production in these States. The period between the middle of March and the middle of April is the time when frosts are most liable to harm the trees. During these few weeks the trees are in bloom and the effect of frosts is to kill the blossoms, resulting in a diminished crop, or no crop at all, of fruits for that year, although the trees themselves are not damaged. Unfavourable weather conditions affect young trees more than older ones and will therefore play a less important part as the plantations grow older.

The only serious disease from which Tung trees have been found to suffer so far is bronzing or rosetting—a withering of the foliage which subsequently kills the trees. This disease is due apparently to soil deficiency and has been overcome by the use of a small amount of zinc sulphate. Hitherto the disease has only occurred in North Central Florida.

Tung oil obtained from American-grown seed is of very high quality and is much better in every respect than that of Chinese origin. So far only comparatively small amounts of Tung oil have been produced in the United States, but larger quantities are expected next year as a considerable acreage entailing many thousands of trees will then come into bearing.

The problem of milling the seed and producing the oil is relatively simple. It is recommended that central factories should be erected in different localities in which the produce from the surrounding plantations would be treated, each mill serving several thousand acres of trees. Although it is not possible to predict with any degree of certainty the cost of production of the oil, it is believed that it will be about 5 cents per pound. The market price of American Tung oil will be influenced by that of the Chinese product, but the former will command a premium over the latter.

In 1930 the United States imported 126 million pounds of Tung oil, and in 1933, 118 million. Last year the consumption in that country was about 108 million pounds and the average price 7 cents per pound. The price is showing an upward tendency and an increased consumption of paint and varnish is expected, which should result in a larger quantity of Tung oil being employed. There is also the possibility to be kept in view of the United States exporting home-produced Tung oil to Europe. This should be accomplished with greater facility than is the case from China, seeing that the American producing areas are all located close to deep-water ports.

Scientific investigations are being carried out with a view to increasing the consumption of Tung oil, and in this connection the following paragraph may be quoted :

" Research is in progress in developing new uses and in improving the quality of the oil both as to colour and odour. . . . Studies are now being made upon a practical scale which may make it possible to greatly increase the life of exterior paints through the use of substantial amounts of specially heat-treated Tung oils. These may act as plasticisers and remain in the film for long periods without the usual form of perishing."

To sum up, the author states that it is now definitely known that the Tung tree will grow and produce bountifully in certain parts of the south, and there is no doubt that in the future a successful Tung oil industry will be established in the United States.

Mineral Statistics.—The 1931–33 edition of the Imperial Institute *Statistical Summary of the Mineral Industry of the British Empire and Foreign Countries* (price 6s.) has recently been issued by H.M. Stationery Office. As in previous years, this volume contains statistics of the production, imports and exports by the different countries of the world of forty-eight minerals, about half of which are metallic. A new table has been added this year showing the output of petroleum refinery products.

The trade tables refer not only to the crude materials but also to the chief semi-manufactured products and in some cases the principal chemicals and derivatives.

A list of the statistical publications consulted by the Imperial Institute in the preparation of this Summary is given in an appendix.

RECENT RESEARCH ON EMPIRE PRODUCTS

A Record of Work conducted by Government Technical Departments Overseas

AGRICULTURE

SOILS AND MANURES

Ceylon.—The following notes are taken from a report on the research work carried out by the Chemical Division during the period January 1 to June 30, 1934.

Ceylon Soil Types.—Two typical up-country soil profiles —the wet patana and dry patana—were studied, the depth of sampling extending to 10 ft. in each case. Both types are characterised by : an A horizon up to about 2 ft. deep in the wet patanas, containing, especially in the latter, very high percentages of organic matter and nitrogen ; a B horizon with a very high stone and gravel content and much lower organic matter and nitrogen contents ; a yellow to red heavy loam, poor in nitrogen and organic matter as the C horizon ; a distinct acid reaction in all horizons, the acidity diminishing slightly with depth in the wet patanas ; low exchangeable base contents, especially in the wet patanas ; fair percentages of phosphoric acid and potash, which tend to increase with depth in the wet patanas ; comparatively high sesquioxide percentages which increase appreciably with depth. The soils appear to be lateritic in type.

An investigation was undertaken to ascertain the relationship, if any, between forest soil type and the growth of Hora (*Dipterocarpus zeylanicus*) in the low-country wet zone of the island. Seven soil profiles up to a depth of 4 ft. were studied. The soils were all lateritic in type, but varied in texture from light to heavy clay loams. The growth of Hora appeared, however, to be better on soils showing high colloid moisture contents. It was also observed that the percentage of stones and gravel and the degree of compactness of the latter in the soil profile govern crop growth to a marked extent ; where these form a pan-like mass, growth is poor. The investigation appears to indicate that the superficial examination of soil profiles of at least 4 ft. depth will give a good idea of the suitability of the soil for afforestation with Hora. Chemically the soils are all extremely poor in replaceable bases, but well supplied with nitrogen and humus in the A horizons. They are all definitely acid in reaction.

Manures.—Investigational work on the preparation of compost manure from street refuse, with and without night soil, which is being done by the Medical Department, was continued. The following conclusions have been drawn: (1) night-soil refuse compost is richer in potash and phosphoric acid than refuse compost; (2) a charge of about 15 per cent. night soil is sufficient for the production of a decomposed product; (3) a proportion of one of activator (decomposed compost) to four of refuse is sufficient to ensure a satisfactory breakdown in a period of two months.

COVER CROPS

Uganda.—The following notes on experiments with various cover crops carried out at the Serere Plantation are contained in the report for the period January to June 1934.

Clitoria cajanifolia has grown very slowly and produced very little cover.

Indigofera endecaphylla is the most successful of the procumbent introductions and after two weedings it covers the ground completely when planted at a spacing of 2 ft. × 2 ft. It maintained a good cover during the dry season.

Indigofera arrecta has proved a failure both as a cover crop and as a green manure at Serere.

Tephrosia Vogelii and *Tephrosia candida* are the best of the erect bushy type of cover crop and provide good shade for the land during the dry season. Unfortunately both suffered from attacks of beetles (*Sphenoptera* sp.), which did considerable damage to the pods.

Crotalaria spectabilis has been a complete failure. Only a few plants were obtained and these produced no cover and set no seed.

Dolichos Hosei grew very slowly in the first nine months and gave but little cover, but later produced an excellent cover of the procumbent type somewhat like *Centrosema pubescens*, but with less tendency to form clumps.

Phaseolus lunatus failed owing to disease and dry conditions.

Soy beans (1.C. T.A. Strain " L ") produced a good crop, and selections were made for two types: (*a*) production of foliage for green manure, (*b*) production of seed.

Of the cover crops used at Serere in the past few years the most successful have been: (*a*) *Stizolobium deeringianum* for temporary cover of about nine months and for green manure, and (*b*) *Centrosema pubescens* for permanent cover.

INSECT PESTS

Termites

Ceylon.—The work on termites carried out by Mr. F. P. Jepson, Controller of Plant Pests, during the period January to June is summarised in the following report.

Tea Termites.—Studies in the bionomics of *Neotermes militaris* and *Glyptotermes dilatatus*, both pests of tea bushes, have been continued but are still incomplete. The Paris Green treatment of tea bushes infested by these pests is still practised with success, but the need for a form of microphone for the detection of infested bushes is very evident.

Tests of Building Materials.—Various tests of building materials and of reputed anti-termite preparations have been conducted. Much time has been devoted to the location of the entrance places of subterranean termites into buildings, particularly estate factories.

Treatment of Termite Nests.—The treatment of the nests of subterranean termites by the injection of petrol into their central nests still indicates that a 100 per cent. mortality of colonies can be secured by this method. Some thousands of nests have now been so treated.

Dry-wood Termites and Sprue.—The hypothesis advanced by Mr. Jepson (*Ceylon Journal of Science, Section D, Medical Science*, Vol. III, **1**, pp. 1–46) that the contamination of human food by the solid excreta of dry-wood-inhabiting termites leads, directly or indirectly, to the causation of sprue and allied intestinal disorders, has resulted in requests for a large number of residences in the island to be examined, requests which, so far as funds and time have allowed, have been acceded to.

The bacteriological study of the fæcal pellets of these insects, and of their intestines, has been continued by Dr. L. F. Hirst, Microbiologist to the Colombo Municipality, who reports the isolation of an organism upon which attention is now being concentrated.

Book-poison Tests.—The exposure tests of treated books against insect injury which have been undertaken at the request of the Crown Agents for the Colonies have been concluded and the volumes have been returned to London. A second series of treated volumes has recently been received for similar tests which are now in progress.

BEVERAGES

Cocoa

Ceylon.—According to the half-yearly report of the Mycological Division, January to June 1934, a second note on the disease of cacao which caused so many casualties in the Dumbara Valley in 1933 has been submitted for publication. In that note the disease was considered to be the same as that called *morte subita* which occurs in islands in the Gulf of Guinea. The name " sudden death " has been given to the disease in Ceylon. The disease is caused by marked fluctuations in rainfall and in this instance it was noted that the weather of 1932, which was usually dry, was followed immediately by excessively wet weather in the first part of 1933. Soil conditions may be contributory. Attention was also drawn to the number of casualties which occur in cacao estates and gardens as the result of wood-rot which starts from unprotected pruning cuts and other wounds.

Coffee

Ceylon.—In the half-yearly report of the Entomological Division for the half year, January to June 1934, it is stated that the larvæ of *Nygmia flava*, which is an occasional pest of a number of plants of economic importance, caused injury to the foliage of *Coffea arabica* for the first time on record.

The red spider (*Tetranychus bioculatus*) also caused injury to the foliage of this crop, but is usually a pest of drought periods only.

Tea

Ceylon.—The following notes on scheduled pests of tea in Ceylon are taken from the half-yearly report of the Controller of Plant Pests for January to June 1934.

Shot-hole Borer (*Xyleborus fornicatus*).—The regulations governing this pest relate to the control of movement of tea nursery-stock with the object of guarding the mechanical introduction of the pest from infested to non-infested areas. Tea plants are only allowed to be moved from one area to another when accompanied by permits issued by the Controller. During the period covered by this report 306 permits were issued for the removal of 807,550 tea plants, compared with 175 permits for 648,022 plants during the corresponding period of the preceding year. Under the provisions of the Tea (Control of Export) Ordinance, No. 11 of 1933, no further extension of the area under this crop is permitted during the restriction period, and all permits now issued are for the supplying of vacancies in existing plantations.

Tea Tortrix (*Homona coffearia*).—The collection and destruction of egg-masses, larvæ and pupæ of this pest on tea plantations is a measure required by law, and managers of estates are required to furnish quarterly returns to

Government of the number of egg-masses collected. The usual return post-cards were issued to, and received from, 1,110 tea estates relative to the last quarter of 1933 and first quarter of 1934. According to the information furnished in these returns there have been significant increases in Tortrix incidence in Dickoya, Nilambe, Hewaheta Upper, Uda-Pussellawa, Haputale and Madulsima, less marked increases taking place in Pundaluoya and Balangoda, while marked decreases are shown in Dickoya Lower, Dolosbage, Maskeliya, Pussellawa, Dimbula and Maturata, and a slight decrease in Ramboda. A study of the figures relating to the collection of egg-masses of this pest since the measure has been in force indicates that, during this period, a marked decline in the numbers of egg-masses collected has taken place in the districts where the pest was, formerly, most in evidence. This fact may be illustrated by the following figures for the three planting districts which have suffered most severely from the attacks of this pest in the past.

COLLECTION OF TEA TORTRIX EGG-MASSES

	Dimbula	Dickoya	Maskeliya.
1927–28 .	127,750,000	52,000,000	43,000,000
1928–29 .	25,000,000	47,250,000	16,500,000
1929–30 .	38,000,000	30,500,000	14,500,000
1930–31 .	23,000,000	11,500,000	10,750,000
1931–32 .	21,250,000	5,750,000	4,750,000
1932–33 .	15,000,000	9,500,000	3,000,000

Nettle Grubs (*Limacodidæ*).—These pests of tea are proclaimed as such in the Province of Uva only and the form of control prescribed by law is the collection and destruction, within twenty-four hours, of all larvæ and cocoons of these insects found on tea estates.

The pests have been recorded as occurring on a number of estates in Uva during the period covered by this report, but no abnormal outbreaks have been reported.

CEREALS

Rice

Ceylon.—The Government Economic Botanist, in his report for the period January to June 1934, states that the work carried out on paddy was mainly a continuation of that detailed in his last report. The improvement of strains that have been isolated from crosses between Ceylon and foreign rices is being attempted in two ways, by direct selection and by back crossing to the local parent and selecting for the character that parent lacks. Thus the white-testaed Mawi is inferior to the local Mawi in yield;

it is therefore being back crossed to the local Mawi (which is red-testaed) and selected for testa colour. Similarly the crosses between a weak-strawed local form and a stiff-strawed foreign strain are back crossed to the local variety and selected for stiff straw. Other crosses have been made, almost all with the object of introducing white testa into an otherwise desirable strain. Foreign varieties have again been introduced, but at present are not promising. The collection of local varieties proceeds slowly.

The experiments in the science of paddy cultivation are being continued. The third experiment, which is still in progress for the observation of residual effect, tested the efficiency of phosphoric acid applied in different forms and at different times. The first series included applications of P_2O_5 as steamed bone meal, ammonium phosphate, superphosphate and mineral phosphate based on a standard application of $\frac{3}{4}$ cwt. ammonium phosphate per acre and arranged so that each treatment received the same amount of nitrogen and P_2O_5, the extra nitrogen being supplied as sulphate of ammonia. The experiment was carried out in 1/100-acre plots with borders, transplanted, randomised and replicated six times. The results were not significantly different. The second series compared the application of P_2O_5 in 1, 2 and 3 doses. The manure was given as broad and narrow ratio ammonium phosphate and each plot received the same amount of nitrogen. It was applied once just before transplanting; twice before transplanting and before flowering; and three times before transplanting, before flowering and at half ripeness. There were six replications as before and the results were not significantly different. The full results will be reported in the *Tropical Agriculturist*, at the end of the present season.

The attempts to increase the scope of the one *v.* two crops a year experiment by the inclusion of green manure and vegetable crops will have to be abandoned, but the experiment will be continued in its original form. There are areas in Ceylon where the water supply is insufficient to allow of the cultivation of the whole area for both seasons, and accordingly it is arranged that the whole of the water supply shall go to one block of fields during the Maha season and to the other block during Yala. The block that receives no water, and on which paddy cannot be grown, is sometimes cultivated with vegetables, and it was to test the effect of such a crop of vegetables on the succeeding paddy that the treatment was introduced into the present experiment. Unfortunately, the experiment is conducted in an area completely cultivated in paddy, and conditions are much too wet for the successful growth of either vegetables or green manures. Large bunds have been built round the vegetable and green manure plots, but the constant presence of water, combined with the attacks of crabs which burrow in the bunds, result in an amount of seepage that is reflected in a complete failure to grow vegetables, and a very moderate crop of green manure (*Crotalaria juncea*). Accordingly these treatments will be discontinued.

The half-yearly report of the Chemical Division states that the following conclusions were obtained from a study of the results of the second series of soil investigations relative to paddy cultivation: (1) manuring produces significantly higher crop yields irrespective of the planting system, but transplanting alone gives higher yields than those obtained by manuring broadcast and thinned crops; (2) both transplanting and manuring appear to lengthen the period of fertiliser absorption by the crop, possibly due to the development of a more efficient root system. The broadcast crops cease to absorb fertilising constituents a little time after flowering.

A paddy soil on which a crop of paddy had failed revealed on examination the excessively high clay content of 76 per cent., which is apparently the reason for crop failure.

According to the half-yearly report of the Entomological Division, the pests of paddy recorded during the period January to June 1934 were the swarming caterpillar (*Spodoptera mauritia*), *Marasmia bilinealis* heavily attacked by parasites, *Parnara bada*, and the paddy gall fly (*Pachydiplosis oryzæ*), which causes the so-called "silver-shoot" disease. The incidence of *S. mauritia* was widespread, reports having been received of serious outbreaks in several parts of the island. The control of grasses and weeds in the vicinity of paddy fields, at the time of sowing or transplanting, are important precautionary measures, and if the attack is observed in the early stages and prompt remedial measures adopted much damage can be avoided. Birds, particularly crows, are valuable allies during the height of a serious attack where earlier precautionary measures have been neglected.

The half-yearly report of the Mycological Division states that the unusually wet weather prevailing in many districts in the early part of the year led to severe outbreaks of blast disease of paddy caused by *Piricularia oryzæ*. The disease was particularly severe on pure-line paddies grown for the first time in certain localities.

Severe attack was reported on B.11 in parts of the Central Province and on Sudu-heenati in parts of the Southern Province. It is probable that these varieties will become more resistant as they become acclimatised in these localities. The disease was reported to be especially severe on newly opened paddy land.

SUGAR

Cane

Leeward Islands.—The following reports on investigation work on sugar-cane carried out by the Agricultural Departments in Antigua and St. Kitts-Nevis during the half-year ended June 30, 1934, have been forwarded by the Acting Colonial Secretary.

Antigua.—Varietal experiments with plant cane were laid down at Cochranes, Tomlinsons, Parrys, Yorks, Comfort Hall and The Cotton in 1932 and were reaped during the period under review.

The lay-out consisted of eight randomised blocks at each station. There were six varieties and a standard variety at each station. The plots of the six varieties were separated from each other by single rows of the standard variety. This lay-out has not proved entirely satisfactory, owing partly to the small size (20–30 stools) of the individual plots, but chiefly to suppression of the single rows of standard when growing alongside a more vigorous or a quicker-growing variety. The results are shown in the following tables :

TABLE I

COCHRANES

Soil Type : Heavy Calcareous.
Planted : November 23, 1932.
Reaped : February 19 to 21, 1934.

Rainfall :

December 1932	2·70 in.
1933	36·83 „
January to February 1934	2·15 „
Total	41·68 „

Variety.	Cane per acre. *tons.*	Sugar per acre. *tons.*	Sucrose in juice. *lb. per gal.*
B.891	39·3	5·78	2·215
B.11569	37·1	5·03	2·007
B 374	36·5	5·00	2·036
P O.J 2878	35·9	5·28	2·202
B.H.10.12[1]	34·3	5·17	2·254
B.726	34·0	5·15	2·270
B.4507	27·2	3·41	1·867

[1] *Standard. Yield calculated from all rows, as no individual variety appears to have caused suppression.*

Germination at first planting good in case of B.726 and B.11569. After first supplying good in all cases save B.891 and B.4507.

TABLE II

TOMLINSONS

Soil Type: Clay Tuff (saline).
Planted: December 21, 1932.
Reaped: February 23 to 27, 1934.

Rainfall:

December 1932	4·08 in.
1933	38·45 ,,
January to February 1934	1·84 ,,
Total	44·37 ,,

Variety	Cane per acre. *tons*	Sugar per acre. *tons.*	Sucrose in juice *lb per gal*
Co.213	23·8	3·10	1·934
P.O.J 2878	20·9	3·14	2·254
G 119	20·5	2·94	2·124
B.726	18·5	2·90	2·350
B 891	18·3	2·69	2·194
B H 10 12[1]	17·8	2·78	2·338
G 153	14·7	1·93	1·950

[1] *Standard variety Yield calculated from all rows save those bordering P.O.J.2878, which appeared to be suppressed*

Initial germination best in case of Co 213 and B.H.10.12, fair in case of other varieties.

TABLE III

PARRYS

Soil Type: Calcareous
Planted: December 14, 1932.
Reaped: March 14 to 17, 1934.

Rainfall:

December 1932	4·53 in.
1933	40·23 ,,
January to March 1934	3·01 ,,
Total	47·77 ,,

Variety.	Cane per acre. *tons.*	Sugar per acre. *tons.*	Sucrose in juice. *lb. per gal.*
G 119	54·9	7·21	1·945
B.891	51·3	8·18	2·384
B.726	48·5	7·59	2·338
B.374	45·1	6·69	2·223
P.O.J 2878	44·7	6·78	2·270
B.6308[1]	37·0	4·62	1·841
B.3922	36·1	5·28	2·163

[1] *Standard variety. Yield calculated from rows bordering B 3922.*

Initial germination was poor, especially in the case of P O J.2878 and B 6308.

TABLE IV

YORKS

Soil Type: Alluvial.
Planted: December 15, 1932.
Reaped: March 20 to 21, 1934.

Rainfall:

December 1932	4·29 in.
1933	43·89 ,,
January to March 1934	5·14 ,,
Total	53·32 ,,

Variety.	Cane per acre. *tons.*	Sugar per acre. *tons.*	Sucrose in juice. *lb. per gal.*
P.O.J.2878	32·0	4·54	2·129
B 726	28·1	4·29	2·283
B.4507	27·8	3·41	1·823
B 891	27·0	4·24	2·358
B 374	26·7	3·89	2·176
B 6308[1]	24·3	2·62	1·602
Co 213	23·2	2·75	1·776

[1] *Standard variety Yield calculated from all rows and may suffer from suppression by more vigorous varieties.*

Initial germination poor except in case of Co 213.

TABLE V

COMFORT HALL

Soil Type : Light Calcareous
Planted : November 30, 1932.
Reaped : April 17 to 19, 1934

Rainfall :

December 1932	4·22 in.
1933	38·64 ,,
January to March 1934	3·49 ,,
Total	46·35 ,,

Variety.	Cane per acre *tons.*	Sugar per acre *tons.*	Sucrose in juice. *lb per gal*
P O J 2878	44·5	6·69	2·259
B 891	43·6	7·10	2·434
B 11569	37·0	5·24	2·106
B H 10 12	36·8	5·87	2·382
B 726	36·2	5·53	2·288
B 3922	23·5	3·34	2·114
B.4507[1]	—	—	2·210

[1] *Standard variety. Yield not calculated, as this cane was badly suppressed by quicker-growing varieties.*

Germination was poor, especially in the case of B.4507, B.3922 and B.H.10.12.

TABLE VI

THE COTTON

Soil Type : Calcareous.
Planted : December 7, 1932.
Reaped : April 25 to 27, 1934.

Rainfall :

December 1932	4·20 in.
1933	32·59 ,,
January to April 1934	3·47 ,,
Total	40·26 ,,

Variety.	Cane per acre. *tons*	Sugar per acre. *tons.*	Sucrose in juice. *lb. per gal.*
P.O.J.2878	38·7	6·07	2·353
B 891	34·9	5·76	2·470
B 11569	34·7	5·26	2·267
B 374	32·2	4·97	2·327
G.119	31·4	4·52	2·140
B 726	27·2	4·52	2·495
B 4507[1]	—	—	2·311

[1] *Standard variety Yield not calculated, as this variety was badly suppressed by quicker-growing varieties.*

Initial germination poor in case of G 119 and B.4507.

The following table shows the summarised yields for the three varieties B.891, B.726 and P.O.J. 2878, which have been grown at all the six stations.

Station.	B 891		B 726		P O J 2878	
	Cane per acre	Sugar per acre	Cane per acre	Sugar per acre	Cane per acre.	Sugar per acre.
	tons	*tons*	*tons*	*tons*	*tons.*	*tons.*
Cochranes	39·3	5·87	34·0	5·15	35·9	5·28
Tomlinsons	18·3	2·69	18·5	2·90	20·9	3·14
Parrys	51·3	8·18	48·5	7·59	44·7	6·78
Yorks	27·0	4·24	28·1	4·29	32·0	4·54
Comfort Hall	43·6	7·10	36·2	5·53	44·5	6·69
Cotton	34·9	5·76	27·2	4·52	38·7	6·07
Mean	35·7	5·64	32·1	4·99	36·1	5·42

B.891 has done particularly well on the calcareous soils. This cane, together with B.726, has a high sucrose content throughout the grinding period covered by these experiments.

The highest individual tonnage record is 54·9 tons cane per acre in the case of G.119 at Parrys, but the sucrose content of the juice was poor compared with that of B.891, B.726 and P.O.J. 2878.

Fourteen cultural experiments, ten with plant cane and four with ratoons, have been laid down during the season 1933–34, these will be reaped in 1935 and will be reported when reaped.

The spacing and method of planting experiment conducted with plant canes at the Greencastle Experiment Station in 1932–33 was reaped as first ratoons in 1934. The following table shows the mean yields of the different treatments.

Flat Planting spaced 4½ × 2 ft.	24·9 tons per acre.
,, ,, ,, 4½ × 4 ft.	23·8 ,,
Vertical ,, ,, 4½ × 2 ft.	23·3 ,,
,, ,, ,, 4½ × 4 ft.	23·5 ,,
Mean of all Flat plots	24·3 ,,
,, Vertical plots	23·5 ,,
,, Close-spaced plots	24·2 ,,
,, Wide-spaced plots	23·7 ,,

As was the case with the plant canes, flat planting and close spacing have resulted in slightly increased yields, but again the differences are not significant.

St. Kitts-Nevis.—The work conducted by this Department comprised variety trials, various manurial experiments, a spacing experiment and different methods of treatment of ratoon canes. Particulars of the experiments and the results are given in the following tables.

TABLE I

Variety Trial—Molineux Estate

PLANT CANES

Planted : November 1932. Reaped : April 4 to 6, 1934.
Manurial treatment : 25 tons pen manure per acre before planting and 2 cwts sulphate of ammonia in January 1933.
System of replication : one 7 × 7 Latin square
Area of each plot : $\frac{1}{20}$ acre weighed Border rows discarded.
Soil : Sandy loam.

Variety.	Cane.		Extraction, per cent.	Sucrose in juice, lb per gallon	Purity.	Sucrose in juice.	
	Tons per acre	Per cent of mean.				lb. per acre.	Tons per acre.
B 374 .	47·90	111·9	50·3	1·875	90·8	9,400	4·20
B.831 .	44·50	104·1	50·7	2·068	94·0	9,700	4·33
B 891 .	43·86	102·7	51·9	1·999	92·5	9,420	4·21
B.H.10 (12)	43·25	101·2	51·1	2·080	92·5	9,500	4·24
G.119 .	41·72	97·6	51·4	1·840	91·0	8,220	3·67
B.726 .	39·31	92·0	50·9	2·009	92·6	8,330	3·72
S.C 12 4 .	38·65	90·5	50·6	1·891	91·2	7,700	3·44
Mean .	42·73	100·0	51·0	1·966	92·1	8,900	3·97

The data given are the means of 7 plots or analyses.

The standard error of the difference between any two mean yields is 1·29 tons per acre, and a difference of 2·63 tons per acre may be regarded as significant with a 20 : 1 probability.

TABLE II

Variety Trial—Molineux Estate

FIRST RATOON CANES

Cut as plant canes : March 1933.
Reaped as first ratoons : March 9 and 10, 1934.
Manurial treatment as ratoons · 4 cwts. sulphate of ammonia per acre.
System of replication : Four randomised blocks
Area of each plot : 100 holes—approx. $\frac{1}{20}$ acre—weighed.
Soil : Sandy loam

Variety.	Cane		Extraction, per cent.	Sucrose in juice, lb per gallon.	Purity.	Sucrose in juice.	
	Tons per acre	Per cent of mean				lb. per acre.	Tons per acre.
B.H.10 (12)	38·90	124·8	56·3	1·961	93·5	8,910	3·98
B.726 .	33·46	107·3	53·7	2·218	95·1	8,210	3·67
B.374 .	31·62	101·4	54·3	3·035	93·7	7,250	3·24
P.O J.2878	30·49	97·8	53·0	2·136	92·9	7,130	3·18
S.C.12.4 .	28·40	91·1	51·5	2·191	94·4	6,610	2·95
G.119 .	27·84	89·3	53·5	2·045	93·8	6,290	2·81
B.417 .	27·46	88·1	53·3	2·059	93·0	6,110	2·72
Mean .	31·17	100·0	53·7	2·092	93·8	7,220	3·22

The data are the means of 4 plots or analyses.

The standard error of the difference between any two mean yields is 1·60 tons per acre, and a difference of 3·36 tons per acre may be regarded as significant with a 20 : 1 probability.

TABLE III

Variety Trial—Buckleys Estate

FIRST RATOON CANES

Cut as plant canes February 1933
Reaped as first ratoons February 19 to 21 1934
Manurial treatment 300 lb sulphate of ammonia per acre
System of replication Four randomised blocks
Area of each plot $\frac{1}{20}$ acre weighed Border rows discarded.
Soil Sandy loam

Variety	Cane		Extraction per cent	Sucrose in juice lb per gallon	Purity	Sucrose in juice	
	Tons per acre	Per cent of mean				lb per acre	Tons per acre
G 119	29 66	119 9	54 3	1 975	92 3	6 590	2 94
P O J 2878	26 60	107 6	52 5	2 121	91 9	6 130	2 74
B H 10 (12)	26 26	106 2	51 5	2 133	92 4	5 960	2 66
S C 12 4	24 07	97 3	50 3	2 054	92 8	5 150	2 30
B 726	23 25	94 1	54 0	2 290	95 3	5 890	2 63
B 374	22 26	90 1	52 0	2 019	91 6	4 940	2 21
B 417	20 98	84 8	53 0	2 235	93 0	5 130	2 29
Mean	24 73	100 0	52 5	2 118	92 8	5 680	2 54

The data are the means of 4 plots or analyses

The standard error of the difference between any two mean yields is 1 74 tons per acre and a difference of 3 66 tons per acre may be regarded as significant with a 20 1 probability

TABLE IV

Effect of Dressings of Pen Manure Sulphate of Ammonia and a complete Inorganic Fertiliser on Plant Canes

Station · Buckleys Estate
System of replication Three 3 × 3 Latin squares
Area of each plot $\frac{1}{20}$ acre weighed Four border rows discarded
Soil Sandy loam
Variety . S C 12 4

Treatments

1 Pen manure Usual dressing for the island approximately 25 tons per acre
2 Sulphate of ammonia, 300 lb per acre
3 Complete inorganic fertiliser consisting of
   336 lb sulphate of ammonia per acre
   112 lb superphosphate of lime per acre
   224 lb sulphate of potash per acre

Planted November 1932
Manures applied

1 The pen manure was applied under the " centres " before planting
2 150 lb sulphate of ammonia were applied on January 11, 1933, and 150 lb in July 1933
3 168 lb sulphate of ammonia and the phosphate and potash were applied on January 11 1933, and the second dose of 168 lb of sulphate of ammonia in July 1933

Reaped : March 12 to 15, 1934

Treatments	1.	2	3	Mean.
	Pen manure	Sulphate of ammonia	Complete inorganic fertiliser	
Tons of cane per acre	37·27	33·95	36·46	35·89
Per cent of mean	103·8	94·6	101·6	100·0

Each yield is the mean of 9 plots

The standard error of the difference between any two mean yields is 1·05 tons per acre, and a difference of 2·59 tons per acre may be regarded as significant with a 20 : 1 probability

TABLE V

Effect of Dressings of Pen Manure Sulphate of Ammonia and a complete Inorganic Fertiliser on Plant Canes

Station Mills Estate

System of replication Four 3 × 3 Latin squares

Area of each plot Slightly under $\frac{1}{10}$ acre weighed Border rows discarded at time of reaping

Variety · B H 10 (12)

Treatments

1 Pen manure Usual dressing for the island, approximately 25 tons per acre

2 Sulphate of ammonia—4 cwts per acre

3 Complete inorganic fertiliser consisting of

336 lb sulphate of ammonia per acre
112 lb superphosphate of lime per acre
224 lb sulphate of potash per acre

Planted November 1932

Manures applied

1 The pen manure was applied under the " centres ' before planting

2 2 cwts sulphate of ammonia were applied on January 17, 1933, and 2 cwts on June 17 1933

3 168 lb sulphate of ammonia and the phosphate and potash were applied on January 17 1933 and the second dose of 168 lb sulphate of ammonia on June 7 1933

Reaped May 1 and 2, 1934

Treatments	1	2	3	Mean
	Pen manure	Sulphate of ammonia	Complete inorganic fertiliser	
Tons of cane per acre .	38·65	36·56	37·91	37·71
Per cent of mean .	102·5	97·0	100·5	100·0

Each yield is the mean of 12 plots

The standard error of the difference between any two mean yields is 0·69 tons per acre and a difference of 1·59 tons per acre may be regarded as significant with a 20 : 1 probability

TABLE VI

Graded Dressings of Sulphate of Ammonia and Pen Manure to Plant Canes

Station Molineux Estate

System of replication Four 4 × 4 Latin squares

Size of each plot Slightly under $\frac{1}{30}$ acre weighed Border rows discarded at time of reaping

Variety B H 10 (12)

Treatments :

1. Control. (When the experiment was laid down it was not intended to give any manurial treatment to these plots, but, in the interests of the estate, an application of 2 cwts of sulphate of ammonia per acre was given in June 1933.)
2. 15 tons pen manure per acre and 2 cwts of sulphate of ammonia. The sulphate of ammonia was given in two doses, one-half about six weeks after planting and the other half at the beginning of the rainy season.
3. 15 tons of pen manure per acre and 3 cwts of sulphate of ammonia. The sulphate of ammonia was applied as in treatment No 2
4. 15 tons of pen manure per acre and 4 cwts of sulphate of ammonia. The sulphate of ammonia was applied as in treatment No. 2.

Planted : November 1932

Manures applied : The pen manure was applied under the " centres " before planting The first application of sulphate of ammonia was made in January 1933, and the second application in June 1933.

Reaped : April 10 to 13, 1934.

Treatments	1 Control	2 15 tons pen manure and 2 cwts S/A	3. 15 tons pen manure and 3 cwts S/A	4. 15 tons pen manure and 4 cwts S/A	Mean.
Tons of cane per acre . .	36·36	42·41	42·34	41·59	40·68
Per cent. of mean	89·4	104·3	104·1	102·2	100·0

Each yield is the mean of 16 plots.

The standard error of the difference between any two mean yields is 0·98 tons per acre, and a difference of 2·04 tons per acre may be regarded as significant with a 20 : 1 probability.

TABLE VII

Application of Sulphate of Ammonia to Plant Canes

MANSION ESTATE

Plot.	Yield, tons per acre	
	A Single application	B Double application
A.1 and B 1	45·27	41·13
B.2 and A 2	41·93	52·99
A.3 and B 3	42·28	35·13
B 4 and A 4	40·61	33·06
A 5 and B 5	32·95	49·88
B.6 and A 6	40·20	37·21
A.7 and B.7	45·15	46·08
B 8 and A.8	29·72	38·59
A.9 and B 9	36·86	34·56
B.10 and A 10	41·59	46·66
A.11 and B 11	36·86	38·02
B.12 and A.12	39·74	38·02
Mean . .	39·43	40·94
Difference . .	+ 1·51	

Statistical analysis of the yield data shows that the standard error of the difference between the mean yields of the twelve replications is 2·10 tons per acre. The difference of 1·51 tons per acre between the mean yields of the two treatments is therefore not significant

TABLE VIII

Time of Application of Sulphate of Ammonia to First Ratoon Canes

COLLEGE ESTATE

Plot.	Yield, tons per acre	
	A Early application	B Late application.
A 1 and B 1	34·81	43·87
B 2 and A 2	37·71	44·49
A 3 and B 3	43·90	46·62
B 4 and A 4	38·53	41·44
A 5 and B 5	38·33	35·22
B 6 and A 6	41·44	45·45
A 7 and B 7	39·36	36·26
B 8 and A 8	32·63	40·92
A 9 and B 9	38·85	40·92
B 10 and A 10	37·51	39·88
A 11 and B 11	41·44	35·96
B 12 and A 12	37·91	43·51
Mean	38·56	41·21
Difference	+ 2·65	

Statistical analysis of the yield data shows that the standard error of the difference between the mean yields of the twelve replicates is 1·26 tons per acre The difference of 2·65 tons per acre between the mean yields of the two treatments is therefore significant

TABLE IX

Effect of Applications of Potash to Second Ratoon Canes which had received Pen Manure in the Plant Canes and Sulphate of Ammonia and Potash in the First Ratoon Canes

Station Molineux Estate
System of replication Four randomised blocks
Area of each plot Slightly under $\frac{1}{40}$ acre weighed Border rows discarded at time of reaping
Variety B H 10 (12)
Treatments
1 4 cwts sulphate of ammonia per acre
2 4 cwts sulphate of ammonia per acre
240 lb sulphate of potash per acre
Reaped as first ratoon canes May 18 to 23, 1933
Manures applied Sulphate of potash on June 1, 1933, and sulphate of ammonia
Reaped as second ratoon canes May 3 and 4, 1934

Treatments	Sulphate of ammonia	Sulphate of ammonia and potash	Mean.
Tons of cane per acre	41·96	42·40	42·18
Per cent of mean	99·5	100·5	100·0

Each yield is the mean of 16 plots.

TABLE X

Spacing Experiment—Molineux Estate, 1932–34

Spacing		Plant canes Tons per acre	Ratoon canes Tons per acre	Total	Per cent of mean.
Row width	Between plants				
3 ft	4 ft	31 84	36 34	68 18	101 7
3 ft	2 ft	35 26	36 51	71 77	107 0
3 ft	1 ft	37 55	38 52	76 07	113 5
4½ ft	4 ft	27 00	34 11	61 11	91 1
4½ ft	2 ft	33 26	35 98	69 24	103 3
4½ ft	1 ft	36 11	36 88	72 99	108 9
6 ft	4 ft	22 08	33 01	55 09	82 2
6 ft	2 ft	29 58	33 82	63 40	94 5
6 ft	1 ft	32 64	32 92	65 56	97 8
Mean		31 70	35 35	67 05	100 0

TABLE XI

Cultivation of Ratoon Canes

Station West Farm
System of replication Four randomised blocks
Area of each plot 0 25 acre weighed
Variety S C 12 4
Treatments
A Stumps moulded no further treatment
B Stumps moulded Trash hauled on alternate banks Untrashed banks subsoiled and cultivated according to usual practice
C Stumps moulded Both banks subsoiled after reversing the trash Trash left on one bank and untrashed bank cultivated according to usual practice
Cut as plant canes June 1933
Fertiliser 2 cwts sulphate of ammonia per acre
Reaped June 1934

Treatments	A	B	C	Mean.
Tons of cane per acre	32 04	29 25	29 70	30 33
Per cent of mean .	105 6	96 4	97 9	100 0

The differences between treatments are not significant

FRUITS

Banana

Ceylon.—The Controller of Plant Pests reports that the virus disease known as "Bunchy Top," which is transmitted from infected to healthy plants by the aphid *Pentalonia nigronervosa*, now occurs throughout the island, with the exception of a clearly-defined zone in the Hambantota District of the Southern Province of which Tissamaharama is the centre. Records of its occurrence have been received from most other districts during the first half of the year. It is not easily controlled, and the prompt destruction of diseased plants and the selection of healthy planting material are the only measures which can be advised at present.

Although stem and root weevils (*Odoiporus longicollis* and *Cosmopolites sordidus*) occur in most ranges of the island where plantains are cultivated, mention of them has only been made from two, Ratnapura and Polgahawela, as was the case in the corresponding period of 1933.

Citrus

Ceylon.—According to the half-yearly report of the Entomological Division, Department of Agriculture, for January to June 1934, the fruit-fly, *Dacus ferrugineus*, caused repeated injury to grape-fruit at Peradeniya and the increasing cultivation of citrus fruits in the island requires the adoption of recognised methods of combating these serious pests. Pests of citrus foliage reported included *Dasychira mendosa* and *Papilio demoleus*, the latter being a common defoliator of citrus trees. The citrus leaf-miner (*Phyllocnistis citrella*) is widespread and occurs in most districts in which citrus is cultivated, but experiments recently concluded in Ceylon indicate that it can be readily controlled by regular spraying with soluble oil emulsions or with nicotine sulphate washes (see below). Its control is important, as the mined areas on the leaves are particularly susceptible to canker infection. The citrus leaf-roller (*Psorosticha zizyphi*) was the subject of special study during the earlier part of the year.

The report of the Mycological Division for the same period states that an experiment has been carried on throughout the half-year to determine the best of the combined fungicides and insecticides commonly in use for controlling citrus canker and citrus leaf-miner in nursery plants. Seedlings of sour orange have been used. Records of the number of leaves affected by citrus canker have been kept. The difference in the growth in the beds under different treatments is now noticeable. The beds sprayed with a mixture of colloidal sulphur and nicotine sulphate are best, while those sprayed with a mixture of an oil spray and colloidal sulphur are also good. The experiment will be continued, but it is obvious from the results obtained to date that, with regular spraying and careful attention, nursery plants can be kept sufficiently free from leaf-miner attack, citrus canker infection and other diseases and pests, to enable them to grow well.

This question is also dealt with in the half-yearly report of the Curator, Royal Botanic Gardens, Peradeniya. He states that canker and leaf-miner continue to be the main enemies of citrus in the Gardens. Spraying with a combination of solol (a white oil) and sulsol with super-arsenate of lead and soft soap keeps these pests and diseases in check if the plants are not too badly infested. Where the leaf-miner occurs, those leaves badly attacked are removed, but care has to be taken not to defoliate to too great an extent, as excessive reduction of leaf surface appears to impair seriously the progress of the plant.

Leaf-miner is particularly serious, because it not only injures the new shoots of the newly budded plant and thus retards the growth progress, but attacks also seedlings, resulting in stunted and damaged growth from the seed-bed stage.

Tobacco leaves from Jaffna and Matale, the tobacco-growing districts, have been obtained and a wash of regulation strength applied, but with no check on the pest. The strength was doubled and then trebled, but no effective results were obtained. It was concluded, therefore, that the varieties of tobacco grown in Ceylon do not possess a sufficiently high nicotine content to act as a remedy for this pest. Latterly a compound of nicotine sulphate has been procured and was given a trial in May of this year. So long as the drier conditions prevailed this was very effective, but since rain was experienced on nineteen of the last twenty-five days in June, applications were not during this period so satisfactory as might be expected. Under normally dry conditions it is believed that this compound will act as a very effective check to leaf-miner ravages.

The Curator also reports that the stock on scion experiment trees continue to make good headway and are now beginning to afford a little information. Lemons budded on Pumelo *in situ* in November 1931 fruited freely at two years of age ; the trees were then 6 ft. in height and very healthy. Lemons budded on sour orange under the same conditions produced fruit on one tree only, but have shown equal rate of growth. The fruits from the sour orange stock, of the same scion parentage as those on Pumelo stocks, were very large (252 grams), more so than those fruits produced on Pumelo stocks.

Mandarins, orange and lime budded on the same combination of stocks at the same dates have yet to fruit, but the mandarins on sour orange stock show good growth and are strong healthy trees, more so than on others of equal age.

The grape-fruit scions (F 5/3) on groups of seven various stocks show considerable variation of growth, ranging from 4 ft. to 10 ft. in height. These were all budded in May 1931, and are expected to show some sign of fruit during 1935. Those on sour orange and *Citrus* sp. (F 4/5) stocks now show most vigorous growth, with those on American or Cuban Shaddock and Pumelo a good second. Those on grape-fruit stock rank next in respect to vigour of growth, with those on *Citrus megaloxycarpa* and the local Nataran last. The last-named stock appears to have a dwarfing effect on the scion, and this is further borne out with individual plants outside the experimental area.

SPICES

Ginger

Ceylon.—The Agricultural Chemist reports that the results of the comprehensive manurial trials with ginger, an account of which was published in the *Tropical Agriculturist*, June 1934, are as follows: (1) local ginger is a significantly better yielder than the Nugegoda (low-country) variety; (2) manuring with artificials at the rate of 5 cwts. per acre is equivalent to manuring with cattle manure at 9·2 tons per acre, an increased yield of over 1 ton per acre being obtained by such manuring; (3) a straw mulch produces a significant increase in yields; (4) liming is no advantage from the stand-point of yield; (5) the yields of ginger vary appreciably with the soil type.

The seed-rate trial indicated that higher yields are obtained with the heavier seed rates, but the proportional increase is lower with the latter. Planting in small sets appears to be preferable to planting in large pieces, as is done locally, from the point of view of ginger curing.

An experiment to determine whether the increased yield of ginger through mulching with straw is due more to the potash content of the latter than to its physical and biological effects on the soil has been designed and laid out at the School Farm, Peradeniya.

Satisfactory methods for the curing of ginger for (1) the local market, (2) the foreign market, without the use of any artificial bleaching agent have been worked out and an article on the subject submitted for publication. Four tons of green ginger were cured by these methods.

In the half-yearly report of the Mycological Division for January to June 1934, it is stated that an experiment has been laid down at the Experiment Station, Peradeniya, to determine the effect of sterilisation of seed ginger on the incidence of diseases such as those caused by *Rhizoctonia solani*, *Sclerotium Rolfsii* and *Pythium graminocolum*. The "seed" ginger was divided into three lots, the first being sterilised soon after harvesting, the second immediately before planting, and the third left untreated as a control. Sterilisation was effected by immersing the ginger in a solution of corrosive sublimate (4 ounces in 30 gallons of water, which is approximately 1 : 1,000) for 1½ hours. The ginger was subsequently dried. A laboratory experiment undertaken previously indicated that this treatment was unlikely to affect germination. Field observations will be made from time to time and the yield of the plots will be recorded separately.

LAWN GRASSES

Uganda.—The following notes on trials with various lawn grasses are taken from a report on the work carried out at the Botanic Gardens, Entebbe, during the period January to June 1934.

Cynodon dactylon (French grass).—Rank growing at first, but inclined to die out somewhat after a while (two or three years) if soil is poor. Perhaps the most common grass used for lawns and short-grass work in Uganda.

Cynodon transvaalensis (Masindi grass).—This has much finer and deeper green leaves than the preceding species and makes a very fine turf where conditions suit it. Unfortunately it is less hardy than French grass.

Eragrostis Mildbraedii.—Indigenous round about Entebbe. A short grass quickly becoming very thick and wiry, and so rather difficult to cut with hand-mowing machines when well established.

Axonopus compressus (Savannah grass).—Indigenous to Uganda. Flourishes where shade and moisture prevail.

Pennisetum clandestinum (Kikuyu grass).—Inclines to grow rank under Entebbe conditions.

Paspalum notatum.—An introduced grass having much broader leaves than any of the former and not so close growing. Has to be propagated from sets, very few flowering spikes being produced to provide seed, other than for a short time after sets have established themselves.

Brachiaria decumbens.—Indigenous to Uganda. Has broad leaves like *P. notatum*, but a looser habit and inclined to ramble.

Chloris pycnothrix.—This grows well and fairly quickly from seed, but after continued cutting mostly stems only remain as the turf. Its habit, however, suggests that it might stand up better to poor soil conditions.

OIL SEEDS

Coconuts

Ceylon.—According to the half-yearly report of the Controller of Plant Pests for January to June 1934, the common pests, black beetle (*Oryctes rhinoceros*) and red weevil (*Rhynchophorus ferrugineus*), have again been reported from the various agricultural ranges of the Central, South-western, North-western, Eastern and Southern Divisions of the island. No serious outbreaks have occurred except on one estate in the North-western Province, where *Oryctes* was found to be breeding in large numbers in decomposing green manure buried around young palms.

Coconut caterpillar (*Nephantis serinopa*) has been reported from one agricultural range, each, in the Eastern, North-western and South-western Divisions. The outbreaks have not been serious.

The occurrence of bud-rot (*Bacillus coli* or *Phytophthora* spp.) has been reported from three ranges in the North-western Division and from two in the South-western Division. The prevalence of the disease led to a special inspection of the surrounding estates being undertaken and all diseased palms being marked down for destruction.

The half-yearly report of the Entomological Division states that the spotted locust (*Aularches miliaris*), an occasional pest of coconuts, caused the defoliation of young palms in one district. The habits of this pest are well known, and it is readily controlled if the egg-laying grounds are marked down and the egg-capsules destroyed. Oviposition takes place in August–September, and there is one generation in the year.

An unusual report of injury to coconut rootlets by cockchafer larvæ was received, but it is considered that the damage in this case was of a casual nature.

According to the half-yearly report of the Mycological Division, sufficient yield records have been obtained from the estates in the Puttalam district referred to in previous reports to conclude the observations on the effect on yield of the severe drought experienced in 1931. Briefly, the maximum effect of the drought in regard to yield made itself evident about thirteen or fourteen months after the conclusion of the drought. This indicates that the developing inflorescences were affected most adversely. An article on this is in course of preparation.

Further investigations have been carried out on the disease of the crown of coconut palms associated with *Thielaviopsis paradoxa*. It has been shown by inoculation experiments that the fungus is capable of causing infection through wounds to produce leaf-break, inflorescence disease and leaf-bitten disease. Field observations have indicated that the last-named disease is a more common precursor of bud-rot of coconuts than has been realised hitherto. Control methods are being investigated, and it is hoped that it will be possible to introduce a method of stopping the disease before the bud is affected and to save trees from death. The investigation is in progress.

Malaya.—The following statement is taken from a report on copra research during the year 1933, by Mr. F. C. Cooke, Officer-in-Charge, Copra Investigations, kindly furnished by the Colonial Office.

Coconut Investigations.—From inspections and analyses carried out in previous years, it has become apparent that wide variations, both in texture and in oil-content, are to be found in copra from different parts of the country and even in copra from a single estate. The indications are that these differences are not occasioned by faulty procedure in manufacture, and that some other cause must be sought. Sundry analyses to determine oil-content of copra from various sources have hitherto provided no conclusive evidence, and it has therefore been decided that a comprehensive inquiry shall be carried out in collaboration with the Division of Plant Physiology, the main purpose being to ascertain the reason for the low oil-content of Malayan copra.

In the year under review, as a preliminary, and in collaboration with the Division of Economic Botany, special attention has been given to dwarf palms, since they appear to be more sensitive to environment than tall palms and respond more rapidly and remarkably to improvement or deterioration in conditions. The copra obtained from all types of dwarf palm was generally found to be more or less inferior to the copra from tall palms, the worst dwarf-palm copra being derived from the red and the best from the green type of dwarf, the latter still being on the average slightly inferior to well-prepared copra from tall palms. Copra of unattractive appearance and texture has, however, been prepared from nuts derived from tall palms growing in a Malay reservation in Selangor, but in general tall-palm copra is of good quality if adequate attention is given during manufacture. Observations indicate that free soil-water movement is an important factor in the problem of the production of coconuts which will yield copra of good quality.

Copra Manufacture.—The crop from the Coconut Selection Station, Klang, has been regularly converted into high-grade copra, both on the brick and on the clay kiln. A full account of the experimental work carried out is in preparation.

The question of the substitution of crude oil burners for shell fuel has been investigated on account of simplicity in kiln attendance charges. It has, however, been calculated that the cost of fuel would be prohibitive in view of the low thermal efficiency of the smoke kiln.

Estates.—A new type of smoke kiln of an improved pattern has been built on one estate in collaboration with the Department, while alterations resulting in an improved product have been effected in existing kilns on other estates. The movement towards improved quality is becoming general and it is now exceptional for an estate not to have attempted or effected some improvement in its product, since with serious over-production in edible oils, copra buyers are becoming more and more discriminating. Notification has been received in three instances that produce of a quality hitherto accepted as estate quality could no longer be paid for at the ruling estate price. Although it is difficult to obtain definite information, it is known that a premium for copra of superior quality has been obtained by certain estates.

Smallholdings.—Increasing attention has also been given to the quality of kampong copra, since it is realised that unless good copra is forthcoming from Malaya in large quantities the chances of advancing the good name of Malayan copra are remote. Arrangements have, therefore, been made for samples of copra from kilns of improved design to be submitted for criticism, grading and valuation on a basis of quality and moisture content. Over sixty samples from seven districts have been examined and the results are most encouraging. Not only have numerous samples been received of average estate quality, but in several instances the copra has been superlative. It has been found that parcels of under-dried copra have been very irregularly valued by small dealers in the kampong.

It has been continuously emphasised that the only sound basis for the permanent establishment of copra manufacture by smallholders is the regular production of dry copra, about which there can be no argument. Any unscrupulous producer attempting to sell water as copra will ultimately be found out and his action will prejudice the interests of other rayat producers. For this reason it has always been found better to centralise manufacture and actively to discourage small individual producers.

It has been noted with satisfaction that the manufacture of copra by the smallholder is not only more profitable than single nut sale to a middleman producer, but the general quality of the copra produced by the smallholder is usually superior to the product hitherto manufactured by merchants in the villages and subsequently marketed by a chain of middlemen to its increasing detriment.

The striking quality of the copra exhibited by smallholders at the Malayan Agri-Horticultural Association Exhibition, 1933, attracted considerable attention and the winning exhibitor was awarded the High Commissioner's Cup for the most outstanding exhibit in the Agricultural Section of the Exhibition.

Copra Grading.—The system of grading copra by marks has been in regular use in the past year and has proved invaluable for recording the quality of successive samples of copra received from estates and smallholdings. It was also successfully applied by the judges on the occasion of the Malayan Agri-Horticultural Exhibition.

Accurate comparisons of samples of copra can now be effected. Marks are deducted according to the deterioration which has already occurred or which may be further anticipated in storage.

When it is necessary to examine a process of manufacture in order to remedy faults in procedure, a different system is adopted. A hundred pieces are subjected to piece-by-piece examination at every stage in the process and a careful count is made to ascertain how many pieces remain unspoiled and how many exhibit specific features. In this way it is easy to determine how and when the process is faulty. A full account is in preparation.

Shipment of Copra.—A shipment of baled copra was inspected on arrival in London. It would appear that some additional trouble is involved when bales are broken up. However, objections hitherto raised that the copra deteriorates more in bales than in bags have not been supported by facts, nor has the suggestion that oil is lost when the copra is compressed for baling.

An attempt has been made to compute the actual loss in copra (i.e. not moisture) when it is stored and shipped. It is known that, if copra leaves a kiln with many pieces exhibiting an active surface bacterial slime, very serious erosion of the copra surfaces can occur. Mould penetration sets in and insect attack follows, where the tissue has been broken down, and opened up. There are practical difficulties in the way of an exact determination of this loss on a single shipment or on bulk storage, while laboratory storage in bags does not reproduce the exact conditions in a warehouse or a ship's hold. Work is still proceeding, but from control analyses made and data obtained from various sources it has been ascertained that the actual loss of copra which occurs in shipment to Europe is approximately as follows :

	Per cent.
Dry white copra (4-day process) . .	negligible
Estate copra	0·5–2·0
Low-grade copra	more than 2

Enquiries in London.—There are dealers in London who are prepared to give a moderate premium for an improved grade of copra. A sample of copra, already receiving a premium, was brought back to Malaya and examined. It was in no way superior either in oil-content or in appearance to the improved estate copra now produced on certain estates in Malaya.

The following account of copra investigations carried out by Mr. F. C. Cooke, during the period January to June 1934, is taken from a further report received from the Colonial Office.

1. *Pre-treatment of nuts before drying.*

(*a*) *The effect on the quality of copra.*—Two series of experiments were carried out following the suggestions contained in a letter from the Director of the Imperial Institute. The freshly split half nuts were carefully dried after receiving the following treatments :

Experiment I (150 nuts).—Nuts were split and put on a smoke kiln with no delay.

Experiment II (150 nuts).—Nuts were sun-dried face upwards for five hours and were then kiln-dried.

Experiment III (150 nuts).—Nuts were drained by inversion for two hours and were then kiln-dried.

Experiment IV (150 nuts).—Nuts were water-washed and were then kiln-dried.

Experiment V (150 nuts).—Nuts were washed in 10 per cent. sodium carbonate solution and were then kiln-dried.

Experiment VI (150 nuts).—Nuts were washed first in 10 per cent. sodium carbonate solution, and afterwards in water ; next they were drained by inversion for one hour, then sun-dried for four hours and subsequently kiln-dried.

In every case good dry copra was obtained : in order to illustrate the comparative effects of the different treatments, samples taken from the various lots were examined piece by piece, each piece being classified according to colour.

Colour of individual pieces.	Number of pieces.					
	I.	II.	III.	IV.	V.	VI.
Snow white . . .	4	3	6	5	2	–
White	4	2	3	5	4	–
Pale yellow . . .	–	3	–	–	1	7
Faint yellow grey (faintly smoked) . . .	2	–	1	–	1	–
Pale brown . . .	–	1	–	–	1	1
Faint reddish-brown (faintly scorched) .	–	1	–	–	1	2

The following remarks on these results may be made :

Draining by inversion (III) gave the best result and alkali-washing the worst (V and VI). Treatment with washing-soda solution appears somewhat to discolour the tissue.

Provided there is no delay, good copra is obtainable even with no pre-treatment of any kind (I), though some smoke adhesion on the wet surfaces is to be expected, and drying requires to be more prolonged.

Draining by inversion and water-washing so as to remove adhering milk gave good results (III and IV). (This is the normal process in the preparation of exhibition copra.)

Further experiments are to be carried out and the effect of sulphuring is to be studied. (Some work has already been carried out with sulphur fumes and it was then found that deterioration of low-grade copra was not prevented by such treatment.)

(*b*) *The effect on the process of drying.*—The effect of soaking half nuts in water, of bacterial sliming, of sun-drying, and of draining of nuts by inversion has been studied in order to ascertain to what extent the effective kiln load is increased or decreased thereby. The true kiln load being the water contained in the material being dried, any removal or addition of moisture before kiln-drying will in effect either reduce or increase the load on the table of a smoke-kiln. On the basis of 250 average-sized nuts being required to produce a picul of copra, it has been previously ascertained that the load ought on no account to exceed twenty-five nuts per square foot of drying platform. In effect, sun-drying reduces this load while rain increases the load by increasing the amount of moisture to be removed.

A number of experiments were carried out to ascertain to what extent the kiln load is affected and on the basis of moisture taken up or lost from the meat and the shell; the following results were obtained:

Treatment.	Effective load nuts per square ft.
(*a*) Basis: Limit of load for freshly split nuts . .	25
(*b*) If these are soaked in water and become slimy through bacterial attack the load becomes equivalent to	29
(*c*) If the 25 nuts are rained on or water-soaked, the load is equivalent to	28½
(*d*) If they are drained by inversion for three hours in the sun, then	23½
(*e*) If they are sun-dried for three hours . . .	20½
(*f*) If they are sun dried for ten hours . . .	14½

Since the quality of copra produced on a smoke-kiln improves with a reduction in load, the good effect of drying split nuts in continuous sunshine for ten hours can be understood (*f*).

The load reduction effect by inversion (*d*) is insufficient to explain the improved quality of the copra which is obtained, and the improvement must therefore be attributed to the complete removal of adherent milk, as stated in a previous section.

The effect of bacterial attack is to increase the moisture content of the copra. It has in practice been found difficult to inhibit such attack once it has set in and moisture removal is therefore considerably retarded during kiln-drying to the detriment of the quality of the ultimate product.

2. *Operation of Kilns.*—The operation of large-scale kilns has supplied useful data in respect of shell firing, fire jump, hot-air movement within the kiln and moisture deposition from hot humid air through cold air leaks. Much experimental work has also been carried out with the object of ensuring correct combustion of shell fuel, ascertaining the causes of kiln fires and determining the causes of faults in manufacture. Existing kilns have been improved and assistance has been given in the design of four new kilns, while a kiln of faulty design has been built at Klang for purposes of demonstration. Information has also been supplied to an estate with regard to the Chula Drier.

3. *High-speed Drying.*—It has been confirmed that the oil-content of copra is to some extent dependent on the method of drying. Copra obtained by slow drying gives a higher percentage of ether extractable material (i.e. oil per cent. dry basis) than does copra that has been dried

more quickly. This is attributed not to actual loss of oil through heat, but to slow decomposition of the tissue of the cell walls, since the actual total oil content remains the same in both cases.

4. *Deterioration in Storage.*—Some further studies of the deterioration of copra have been made and it has been found that gas evolution from dry low-grade copra stored under sealed conditions is not considerable. Further work is contemplated.

Oil Palm

Uganda.—According to a report on experimental work carried out at the Botanic Gardens, Entebbe, during the period January to June 1934, an established plot of 105 oil palms is maintained. More than double this number was originally planted by the Forestry Department some thirteen years ago, but many subsequently became overcrowded and were thinned out. In 1931 some further trees, which had shown no signs of fruiting after the elapse of ten years, were cut out.

Fruiting commenced in 1927, but it was not until the following year when several came into bearing that records of individual trees were attempted. Since then, the recording of both the number of fruits per tree and their total weight at each gathering has continued.

Harvesting of the fruits is usually done once during each month.

Figures of the twenty highest yielders to date are given below, as they show something of the variation in yields; moreover it is from these that an investigation of both fruit and kernel size has very recently been started.

No of palm.	No of fruits.	Weight of fruits at time of harvesting		No of palm	No of fruits	Weight of fruits at time of harvesting	
		lb	oz			lb	oz
6	10,347	548	2	65	7 519	218	11
10	13,036	507	6	68	7,465	289	11
12	13,492	714	1	77	7,308	278	9
19	7,144	196	11	78	7,115	323	9
22	9,049	386	8	82	8,094	278	15
35	8,376	410	2	97	7,203	235	13
41	10,284	353	10	125	10,258	328	14
43	8,031	279	0	157	8,494	353	6
58	8,254	319	10	197	8,877	329	0
62	8,972	272	12	232	7,341	279	2

Palm No. 22 and eleven others yield greenish fruits as opposed to the normal colouring.

The average yield of fruits per palm over all and up to date is estimated to be 176½ lb.

FIBRES

Cotton

Uganda.—The following account of work carried out at the Serere Plantation on the 1933–34 cotton crop is contained in the half-yearly report for the period January to June 1934.

Cotton Breeding Plot and Variety Trial.—The derivatives of Parnell's U.4 have once again shown themselves to be high-yielding, early-maturing strains with good habit and a high degree of resistance to both jassid and blackarm. Their high yields are accentuated by high ginning outturns ; but although some strains have given a staple as long as " East African," none has yet given lint of quite the same character as " East African." S.G.29, a Nyasaland Upland variety which is being adopted as standard in the Eastern Province, has an excellent name on the Liverpool and Bombay markets for the length and character of its staple, but it is a comparatively low-yielding strain and is susceptible to blackarm. The Nariama strains, derived from S.G.29, retain the resistance to blackarm for which the Nariama plant was originally selected ; but they are low-yielding, more susceptible to jassid, and, although their lint has the character of " East African," the staple tends to be shorter.

Two series of Harland's hybrids between U.4 and other varieties, sent from Trinidad, were tried in the breeding plot. The first series, particularly those hybrids containing elements of U.4, Cambodia and Jamaica Xerophytic, showed great promise.

Cotton Variety, Sowing Date and Dusting Trial.—The varieties S.G.29 and S.P.1 (a derivative of U.4/4/2) were placed in a trial with four sowing dates (May, June, July, August) and three seed-dusting treatments (" Abavit B.," " 413a " and Control). A great deal of information was obtained from this experiment, and the dust " 413a " is now used as a routine measure on all seed sown in increase plots at Serere.

Cotton Sowing Date and Spacing Trial.—Three sowing dates (May, June, July) were combined with three spacings (3 ft. × 1 ft., 3 ft. × ½ ft., 3 ft. × ¼ ft.) using the variety S.G.29 to see whether very close spacing could compensate for late planting. No significant results emerged from the trial, and pending further trials, it is assumed that close spacing cannot make up for delay in planting.

Cotton Variety and Spacing Trial.—Four spacings (3 ft. × 2 ft., 3 ft. × 1 ft., 3 ft. × ½ ft., 3 ft. × ¼ ft.) were tried with the two varieties S.G.29 and S.P.1. An optimum spacing of about 3 ft. × 1½ ft. was obtained for S.P.1 by the method of regression on stand, but no other results emerged from the trial.

Spraying Experiment for Control of Lygus on Cotton.—An experiment was laid down with S.G.29 cotton to try the effect of spraying with tobacco extract against a control spraying with water only and a control unsprayed. The plots sprayed with tobacco extract appeared to show less leaf perforation and to remain greener than both controls; but the yield from these plots, though greater than that from the controls, failed to establish a significant result.

Increase Plots.—The varieties S.P.20, S.P.21, S.P.23 (derivatives of U.4/4/2) and S.P.36 (Nariama) reached the ¼-acre increase plots. S.G.29 was multiplied in the 3-acre plot. There was no 30-acre increase on account of the reorganisation of the farm, and the Mulondo Segregated Area was resupplied with its own seed.

Manurial Experiment.—The effect on subsequent cropping of a single application of manure is being tried in a 5 × 5 Latin square, the five manurial treatments being:

(*a*) Farmyard manure 30 tons per acre.
(*b*) Farmyard manure 20 tons per acre.
(*c*) Farmyard manure 10 tons per acre.
(*d*) Lime 2 tons per acre.
(*e*) Control.

The manurial treatments were applied at the start and cropping began in 1933 with a green manure crop (*Crotalaria juncea*) followed by cotton. There were no significant differences in the yields of cotton; it had suffered severely from Lygus damage and blackarm and the average yield was 360 lb. per acre. Bulo (*Eleusine coracana*) was sown in 1934.

Soil Erosion Experiment.—Cotton was harvested from this experiment in February 1934. The bottom terrace showed a significant increase in yield over the two upper ones. There were no differences brought about by the erosion stops of pigeon pea and lemon grass or by ditching.

Rotation Experiment.—Cotton was harvested from this experiment in February 1934. It had been sown very late after food crops and the 1933–34 season was distinctly unfavourable for late-sown cotton. No significant results have yet emerged from this experiment, which is now in its second cycle, and the land is becoming markedly impoverished. It was found possible to transplant seedlings of sim-sim (*Sesamum indicum*) in order to obtain an even stand.

The report on the work conducted at the Bukalosa Experiment Station during the same period was as follows :

The cotton breeding work has proceeded on the same lines as in previous years, and several new strains in the pedigree lines showed considerable promise. In the variety trial, S.G.23/8 showed superiority to Local in lint yields, and on account of its very much better spinning qualities it is probably a better cotton than Local.

The results of experiments on tractor cultivation as compared with hoe cultivation, combined with a spacing trial, were inconclusive, apart from the fact that 3 ft. × 1 ft. spacing gave a significantly better yield than 4 ft. × 1½ ft.

The mulching of August-sown cotton with elephant grass gave a significant increase in yield over control, but the high cost of mulching more than cancelled out the value of the increase crop. The residual effect of the mulch will be tested next season.

A test of the effect of rotted cotton seed, green manure in the form of *Crotalaria juncea* and a combination of the two on a cotton—ground-nut—sweet potato—cotton rotation was laid down this season. Cotton seed alone and cotton seed with green manure gave significant increased yield over green manure alone and control. No difference between green manure and control was obtained. Apart from its effect on yield cotton seed had a distinctly early maturing effect on the cotton. The residual effect will be tested on ground-nuts and sweet potatoes.

RUBBER

Para

Ceylon.—According to the half-yearly report of the Mycological Division, Department of Agriculture, for January to June 1934, the disease which attracted most attention during the period was Hevea mildew (*Oidium heveæ*). The disease, which hitherto caused serious damage only at mid-country elevations, has caused severe defoliation of rubber in all districts this year. It is not yet clear whether this extension of attack is associated with the prevalence of weather conditions unusually favourable to the fungus or whether the disease is becoming acclimatised in low-country districts and, in consequence, may be expected to become progressively more serious in those districts. If the latter alternative is correct, then a rapid extension of the practice of sulphur dusting may be expected in the near future. Sulphur dusting gives satisfactory control of the disease under estate conditions.

TOBACCO

Ceylon.—According to the half-yearly report of the Entomological Division, Department of Agriculture, for January to June 1934, injury caused by tobacco aphis (*Myzus persicæ*) has been common in several tobacco-growing areas. It is readily controlled by a soap and water wash in the absence of its natural enemies, particularly Coccinellid and Syrphid larvæ. The larvæ of *Prodenia litura*, *Plusia* sp. and *Heliothis* sp. have been found to cause injury to the foliage. The latter, although an occasional pest of tobacco in other countries, has not hitherto been recorded as a pest of this crop in Ceylon.

FORESTRY

Nigeria.—The following report on recent developments in Nigerian silviculture, prepared by Mr. W. D. MacGregor, Silviculturist, has been furnished by the Director of Forests.

Organised research in the silviculture of the forests of Nigeria was started in 1927 when two officers, trained for this work at Oxford and in India and Burma, were appointed and gazetted as Silviculturists to the Nigerian Forest Service. These officers were stationed at Ibadan and Sapoba for the purpose of studying the silviculture of the mixed deciduous and rain forest types respectively. The initial stages of their work were described in *Bulletin* No. 1 of the Nigerian Forestry Department (to be purchased from the C.M.S. Bookshop, Lagos, and the Crown Agents for the Colonies, London, price 5*s*.). Work up to 1932 will shortly be published in *Silviculture of the Mixed Deciduous Forests of Nigeria*, by W. D. MacGregor,[1] and *Nigerian Trees*, by J. D. Kennedy (Government Printer, Kaduna). It is inadvisable to anticipate these publications, and the purpose of this report is to outline the most recent developments of Nigerian silviculture.

The work undertaken in the mixed deciduous forest zone has comprised experiments relating to nursery and plantation operations and methods of regenerating natural forests. Results of nursery and plantation experiments have now been adopted in general practice over the south-western provinces generally, and the results are most encouraging, especially as regards fuel plantation establishment. One of the main problems, however, has been the conversion of uneconomic forest to economic forest. Experiments in line planting and broadcasting with natural regeneration under the Shelter Wood System have produced such excellent results that operations have now been extended over large areas to test their practical application and costings. During the year 1934, 175 acres were established under the Line Planting System in the Mamu forest. This planting has followed exploitation and has every appearance of being very successful. The effect of creeper cutting and improvement fellings is being studied in relation to girth increment and the survival of the sapling and pole stage of natural regeneration. Taungya has been started at Mamu over an area of 40 acres and, judged by the keen demand for farms by the natives, there is considerable promise that this method will take a prominent place in the regeneration of this forest. It may be stated that the regeneration methods are established and are ready for application under Working Plans.

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[1] Since this report was prepared Mr MacGregor's book has been issued by the Clarendon Press as *Oxford Forestry Memoir No* 18, 1934, price 15*s*

The statistical branch of silviculture has received considerable attention. In addition to sample plots in regular plantations, plots have now been established in the mixed deciduous and rain forests. In these plots all the economic, and many of the secondary species, are measured annually to give data establishing girth increments and rotations. Sample trees over the complete girth range of economic species have been felled on adjoining, or similar areas, and these have been measured to give height, form factor, bark percentage and volume figures. Correlating these figures with the increment and age figures from the sample plots, it will be possible to compile preliminary yield tables.

As an example of the stage the study of silviculture has reached, it will be of interest to quote the case of *Mansonia altissima*. This species has attracted considerable interest in the home market and its silviculture has been studied intensively in Nigeria. Enumeration surveys are defining its distribution, girth range and abundance. Definite positive information has been obtained in relation to its nursery treatment and establishment in plantations. At Mamu natural regeneration experiments have been conducted over a period of four years with gratifying success and it has been established on a large scale on the system of line planting under high forest. Girth increments have been measured over a girth range of 0 to 6 ft. in areas that have been subjected to creeper cutting and improvement fellings. From these increments the rotations for this species to reach maturity, 6 ft. girth, is assessed at sixty-one years. In Ondo Province a sample plot of 100 acres has been established in the natural forest and in a short period increment data will be available for this locality also. Finally sample trees, extending over the complete girth range, have been and are being felled and measured to give height, form factor, bark percentage and volume data.

To summarise, the most recent developments of Nigerian silviculture are the application of its experiments on a practical basis, and a comprehensive study of the growth factors of economic species. These developments lead the way to Working Plans, without which there can be no progression in forest management.

RESINS

Lac

Ceylon.—The half-yearly report of the Entomological Division, Department of Agriculture, for the period January to June 1934, refers to the attempt now being made to develop a lac industry in Ceylon where there is a local demand for the commodity among lacquer workers and manufacturers of sealing-wax. A limited amount of lac, produced by indigenous species of *Tacchardia*, is still collected from jungle trees by lacquer workers and others, but imported lac and shellac are largely employed. It is not impossible that, under suitable conditions, an export trade in shellac may be developed.

During the period under review, a consignment of 200 lb. of *Laccifer lacca* brood-lac suitable for growth upon *Schleichera trijuga*, a common jungle tree in the forests of the dry zone, was imported from the Indian Lac Research Institute, Ranchi, India, and inoculated upon this tree in the Kandy district during February, which is the driest month in the year. The inoculations were successful and a crop estimated at 600 lb. of brood-lac will be harvested during early July and transported to a district more suited to its successful propagation during the S.W. monsoon season. The region selected abounds in *S. trijuga* and the periods January/February and June/July, the two swarming seasons of this variety of the insect, are normally fine in this area.

A consignment of about 160 lb. of brood of another variety of the same insect, and suited to several host plants, had been despatched from India and was due to arrive on July 3. This consignment was to be transferred to a region of the island where moderately fine weather can be depended upon during June/July and October/November, the swarming seasons of this variety, and where a suitable host, *Zizyphus jujuba*, is abundant.

The two districts selected are those in which wild lac occurs in the forests, in consequence of which lacquer work has been an industry followed by certain members of the population of these districts from ancient times. The resinous incrustation formed by the Indian species is far superior to that of the local forms and it is hoped that a profitable industry may be built up from the imported brood material.

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Administration Report of the Conservator of Forests, Trinidad and Tobago, for the year 1933. Pp. 22, 13½ × 8½. (Port-of-Spain: Government Printer, 1934.) Price 10*d.*

Trees of Trinidad and Tobago. By R. C. Marshall. Pp. 101, 9 × 5¾. (Port-of-Spain: Government Printer, 1934.) Price 3*s.*

Report on an Investigation into the Uses and Marketing of Forest Products in Trinidad and Tobago. *Counc. Paper No.* 100 *of* 1934, *Trinidad and Tobago.* Pp. 85, 13½ × 8¾. (Port-of-Spain: Government Printer, 1934.) Price 2*s.*

Some Trees, Shrubs, Shrubby Herbaceous Plants, Climbers and Water Plants Suitable for the Colony (Southern Rhodesia). By J. W. Barnes. *Rhodesia Agric. Journ.* (1934, **31,** 507–536, 596–606).

Damage to *Pinus monticola* by *Cronartium ribicola* at Garibaldi, British Columbia. By H. G. Lachmund. *Journ. Agric. Res.* (1934, **49,** 239–249).

Selectie-Onderzoek van den Djati (*Tectona grandis* L.f.). By I. C. Coster and F. E. Eidmann. *Korte Med. No.* 40, *v. h. Boschbouwproefsta., Dept. v. Econ. Zaken, Ned.-Indië.* Pp. 41, 9¾ × 6¼. (Buitenzorg: Archipel Drukkerij, 1934.) An account of work on teak selection.

De Kieming van den Djati (*Tectona grandis*). By F. E. Eidmann. *Korte Med. No.* 42, *v. h. Boschbouwproefsta., Dept. v. Econ. Zaken, Ned.-Indië.* Pp. 53, 9¾ × 6¼. (Buitenzorg: Archipel Drukkerij, 1934.) A study of the germination of teak.

The Biological Control of Teak Defoliators. By C. F. C. Beeson. *Indian Forester* (1934, **60,** 672–683).

Bacteriosis (Blight) of the English Walnut in California and its Control. By B. A. Rudolph. *Bull.* 564, *California Agric. Exper. Sta.* Pp. 88, 9 × 6. (Berkeley: University of California, 1933.)

Timbers

Report of the Forest Products Research Board, Department of Scientific and Industrial Research, with the Report of the Director of Forest Products Research for the year 1933. Pp. 67, 9½ × 6. (London: H.M. Stationery Office, 1934.) Price 1*s*. 3*d*.

British Standard Terms and Definitions Applicable to Softwoods. *No.* 565, 1934, *British Standards Inst.* Pp. 36, 8½ × 5½. (London: British Standards Institution, 1934.) Price 2*s*.

Timber Bending. *Trade Circ. No.* 22, *Div. For. Prod., Counc. Sci. Indust. Res., Australia.* Pp. 14, 9½ × 6. (Melbourne: Government Printer, 1934.)

The Shrinkage of Wood During Drying. *Trade Circ. No.* 23, *Div. For. Prod., Counc. Sci. Indust. Res., Australia.* Pp. 15, 9½ × 6. (Melbourne: Government Printer, 1934.)

Research Institutes and Forest Products Laboratories in which Work on the Preservation of Timber is being carried out. *Journ. Brit. Wood Preserving Assoc.* (1934, **4**, 127–131).

Wood Preservation. By A. V. Thomas. *Malayan Forester* (1934, **3**, 119–125). With special reference to Malayan timbers.

Wood Preservation in the Service of the Post Office. By R. G. Bennett. *Journ. Brit. Wood Preserving Assoc.* (1934, **4**, 4–24). Deals principally with the preservation of telegraph poles.

Coal Tar Creosote Oil as a Wood Preservative. By N. A. Richardson. *Journ. Brit. Wood Preserving Assoc.* (1934, **4**, 64–91).

A Record of the Results obtained with Experimental Treated Sleepers laid on the Railways between 1911 and 1916. By S. Kamesam. *For. Bull. No.* 85, *Econ. Series, For. Res. Inst., Dehra Dun.* Pp. 35, 9¾ × 8¼. (Delhi: Manager of Publications, 1934.) Price As. 8 or 10*d*.

The Use of Treated Timber in Railway Construction. By W. H. Brown. *Journ. Brit. Wood Preserving Assoc.* (1934, **4**, 45–46).

Methods of Testing the Susceptibility of Timbers to Termite Attack. By C. Dover and R. N. Mathur. *Indian Forest Records, Entom. Series* (1934, Vol. XX, Part VII, pages 1–20).

Some Economic Aspects of Timber Production in Malaya. By J. N. Oliphant. *Empire Forestry Journ.* (1934, **13**, 45–57).

Notes on Malayan Timbers. Sepetir (*Sindora* spp.), Keruing (*Dipterocarpus* spp.) and Kapor (*Dryobalanops aromatica* and *D. oblongifolia*). *Malayan Forester* (1934, **3**, 138–147).

The Identification of the Commercial Timbers of the Punjab. By K. Ahmad Chowdhury. *For. Bull. No.* 84, *Econ. Ser., For. Res. Inst., Dehra Dun.* Pp. 69, 8½ × 5½. (Delhi: Manager of Publications, 1934.) Price Rs. 3 or 5*s*. 3*d*.

The Composition of Philippine Woods. By H. M. Curran, F. M. Yenko, Luz Baens and A. P. West. *Philippine Journ Sci.* (1934, **53**, 489–494). Deals with the following: *Dipterocarpus grandiflorus, Garcinia venulosa, Quercus bennettii, Diospyros discolor, Adenanthera intermedia, Cyclostemon bordenii, Koordersiodendron pinnatum, Vatica mangachapoi, Bischofia javanica, Ficus malunuensia, Terminalia edulis,* and *Strombosia philippinensis.*

The Softening of East African Pencil Cedar (*Juniperus procera* Hochst.). *Investigation No.* 60, *Project O, For. Prod. Res. Lab., Dept. Sci. Indust. Res.* Pp. 30, 9½ × 7½. (Princes Risborough, Bucks: Forest Products Research Laboratory, 1934.) Mimeographed copy.

Properties of Ceylon Gurjun (*Dipterocarpus zeylanicus* Thw.).

Investigation No. 2, Project No. 24, For. Prod. Res. Lab., Dept. Sci. Indust. Res. Pp. 47, 9¾ × 7½. (Princes Risborough, Bucks: Forest Products Research Laboratory, 1934.) Mimeographed copy.

Jelutong. Damage by Insects and Fungi, and Value of the Timber. *Malayan Forester* (1934, **3**, 133–137).

Results obtained with the Kiln Drying of Laurel (*Terminalia tomentosa*) according to a New Method developed at Dehra Dun. By S. N. Kapur. *Indian Forester* (1934, **60**, 550–558).

The Inter-relationships of Bark Beetles and Blue-staining Fungi in Felled Norway Pine Timber. By J. G. Leach, L. W. Orr and C. Christensen. *Journ. Agric. Res.* (1934, **49**, 315–341).

Gums and Resins

Report of the Kauri Gum Industry, New Zealand, for the year ended March 31, 1934. Pp. 3, 13½ × 8½. (Wellington: Government Printer, 1934.) Price 3*d.*

Philippine Panao (*Dipterocarp*) Resin. By S. S. Tanchico, A. P. West and J. Fontanoza. *Philippine Journ. Sci.* (1934, **54**, 75–79).

Tanning Materials

The Place of Thinning in Wattle Silviculture and its Bearing on the Management of Exotic Conifers. By I. J. Craib. Pp. 32, 9¾ × 7. (Berlin: Verslag J. Neumann, 1934.) Reprinted from *Zeitschrift für Weltforstwirtschaft.*

Modern Methods of Detecting the Causes of Faults in Leather. By D. Jordan Lloyd. *Journ. Fed. Curriers, Light Leather Tanners and Dressers, Inc.* (1934, **15**, 172–182).

Causes and Prevention of Decay in Leather. By R. F. Innes. *Leather World* (1934, **26**, 927–931).

Preliminary Experiments on Prevention of Leather "Red Rot." By R. W. Frey and C. W. Beebe. *Journ. Amer. Leather Chem. Assoc.* (1934, **29**, 528–543).

NOTICES OF RECENT LITERATURE

Books for review should be addressed to "The Editor," Bulletin of the Imperial Institute, South Kensington, London, S.W.7.

FROM EMPIRE TO A COMMONWEALTH OF NATIONS. By C. Midgley, M.Sc. Pp. 64, 9½ × 7. (Exeter: A. Wheaton & Co., Ltd., 1934.) Price 1*s.* 6*d.*

This is the first book in a series of "Sketch Map and Picture Histories," and is evidently intended, like the author's earlier series of "Sketch Map and Picture Geographies," specially for the use of young pupils. The title does not fully indicate the scope of the contents, which form a concise survey of the development of British power overseas from the fifteenth century to the present time.

The volume is interestingly written, attractively produced, and well supplied with maps and pictures. If any criticism can be offered it is that reference is made to certain topical matters in connection with South Africa, Western Australia and Ireland, developments regarding which may shortly make the edition out of date in places. It might have been better to deal only with past history and to leave any comment on current events to the teacher.

A TEXT-BOOK OF WEST AFRICAN AGRICULTURE. Soils and Crops. By F. R. Irvine, D.Sc., F.L.S. Pp. xii + 348, 7½ × 5. (London: Humphrey Milford, Oxford University Press, 1934.) Price 7*s*. 6*d*.

British West Africa affords the most conspicuous example in the Empire of a tropical region where agricultural development remains in the hands of the natives as owners of the soil. As recently as the beginning of this century the agricultural activities of the inhabitants were mainly confined to growing foodstuffs, some cotton, and a few other products for their own use. The exports of vegetable origin, e.g. palm oil and kernels, rubber, timber, fibres, etc., were practically all the produce of wild forest trees.

The position is now very different. Under the guidance and help, first of missionaries and later of Government officers, agricultural and administrative, the West Africans have attained an important position amongst the world's agriculturists. The most striking example is with cocoa, of which the Gold Coast supplies about one half and Nigeria one ninth of the world's demands, ranking first and third amongst the world's producers. Good progress, although not so spectacular, has been made with other crops, e.g. ginger and cotton, and quite recently a start has been made with the export of fresh fruits for which a higher standard of skill both in cultivation and handling is essential.

These developments would not have been possible without a great advance in general and agricultural education. How great that advance has been is well shown by the opening lines of the introduction by the author, himself the Senior Science Master at Achimota College. "This book was written primarily for Africans, as an aid to students taking Agricultural Science as a subject in the Cambridge School Certificate Examination. It is hoped that it will be of general use in Secondary Schools, Middle Schools, Training Colleges for Teachers, and in Agricultural Schools and Colleges. Whilst its standard is quite beyond elementary schools, it should serve as a text-book or reference book for elementary school teachers."

Part I is devoted to soils and manures. The central theme is the breaking-down of the old-time system of shifting cultivation due to the increased production of cash crops for export, particularly those obtained from permanent cultivations such as cocoa. This has enforced attention to crop rotations on the areas available for food crops, and consequently to green manuring, the use of animal and other manures, the use of implements, and to the prevention of soil erosion.

Part II deals with a large number of crops, both for local use and for export, whilst Part III treats of such general questions as plant propagation, seed storage, pests and diseases, and the principles of school gardening.

The usefulness of the book is enhanced by thirty-two excellent plates, mainly of agricultural operations and crop plants, and the same number of equally successful line drawings.

This work by Dr. Irvine, in conjunction with Faulkner and Mackie's *West African Agriculture* (see this BULLETIN, 1933, **31**, 306–308) can be confidently recommended to all interested, in whatever capacity, in the agriculture, and consequently the economic development, of this important tropical region of the British Empire.

THE VEGETABLE PRODUCTS OF CEYLON (A Guide to their Identification and Economic Uses). By Frederick Lewis, F.L.S. Pp. vii + 402, 8½ × 5½. (Colombo and London: The Associated Newspapers of Ceylon, Ltd., 1934.) Price 15*s*.

This volume contains the results of the botanical activities of the late Mr. Frederick Lewis during a period of over fifty years. First as a planter, later as Assistant Conservator of Forests and then Land Settlement Officer, he made such good use of his opportunities for studying the local flora that as Mr. C. Drieberg says in his Preface "he was able not only to identify nearly every plant he came across, but also to acquaint himself with its vernacular name, medicinal properties and economic uses."

A few pages are devoted to a general sketch of the flora of the island and notes on the chief plants characteristic of its four climatic zones. The rest of the book is taken up with an enumeration of nearly five hundred plants, mostly native, arranged under their natural orders. The reference to native plants is desirable, because although various introduced plants such as mahogany, arrowroot, maize, areca nut, sugar-cane, etc., are dealt with, others such as tea, Hevea rubber, cacao, etc., have been excluded, although they are amongst the first which would occur to one as "vegetable products of Ceylon."

The information given about each includes its botanical and popular names (English, Sinhalese and Tamil), its description, distribution and uses as a food plant, fibre, timber, local medicine, etc. Reliable data of this nature are very difficult to secure; natives will often give some information rather than be so impolite as to say they do not know. As a visiting botanist found, a good many years ago in Ceylon, the same native name was given to different plants. The defence of the informer when challenged was "No matter, Master put them all in one book." Mr. Lewis's long experience of the country and its people and his great zeal doubtless enabled him to secure confirmation of the facts recorded, and this book, which unfortunately he did not live to see completed, will long remain the recognised source of information on the uses of the plants native to Ceylon.

A SUMMARY OF FOOD LAWS AND REGULATIONS. By C. L. Hinton, F.I.C. Pp. vii + 90, 10 × 7½. (London: The Nema Press, Ltd., 1934.) Price 21*s.*

The major portion of this book has been written by C. L. Hinton of the British Association of Research for the Cocoa, Chocolate, Sugar Confectionery and Jam Trades, and consists of two parts, the second being in the form of tables. Some of the chapters have already been published as articles in *Food*, and have been brought up to date for inclusion in the present volume. Each chapter is devoted to one class of products and contains an account of the various food regulations in force in different parts of the British Empire and in foreign countries. The number of commodities covered is comprehensive and includes milk products and cheese; biscuits, cakes and pastry; sugar confectionery; cocoa and chocolate; jams and jellies; canned fruits and vegetables; canned and potted meats; pickles and sauces; and non-alcoholic beverages. Additional chapters deal with preservatives, colouring matters, and labelling. The regulations are summarised in the tables, thereby facilitating the task of ascertaining the standard of purity required for any particular food by any country.

The remaining pages are occupied by two sections. One consists of extracts from enactments of the United Kingdom as affecting the manufacture of foods and deals with the manufacturing aspects as distinct from the purely forensic, whilst the other records the Food Manufacturers' Federation standards for jam.

The book is clearly printed and is furnished with two indexes, one referring to the contents of the chapters and the other to those of the tables. It should be of value to manufacturers who may be desiring to explore new markets or to control the composition and quality of their products in accordance with the requirements of existing markets. To those engaged in the examination of food products the work should be useful for reference purposes.

THE PRINCIPLES AND PRACTICE OF WINE MAKING. By W. V. Cruess, Ph.D. Pp. x + 212, 7½ × 5½. (New York: The Avi Publishing Co., Inc., 1934.) Price $3.50.

Opinions may differ as to the extent to which the art of wine-making can be acquired from books, but, in any case, the practical wine manufacturer cannot fail to find in this little manual much that will be useful to him in the exercise of his calling. It embodies the results of the author's own observations and experience as Professor of Fruit Technology at the University of California, together with information collected from publications of that University and from other sources, and is intended primarily for use in the United States, where the subject presents technical aspects differing in some ways from those of the "classical" wine-making countries.

The book is an eminently readable one and is not without interest to the general reader, who will be able to learn from it much about what constitutes different types of wine; the numerous living organisms, some good, but many bad, that are met with in wine-making; ageing and the problem of its acceleration; the "fortification" of wines; diseases and defects; as well as the mystery of how the sediment is removed from champagne after fermentation has been completed in the bottle.

LABORATORY EXAMINATION OF WINES AND OTHER FERMENTED FRUIT PRODUCTS. By W. V. Cruess, M. A. Joslyn and L. G. Saywell. Pp. xiii + 111, 7½ × 5. (New York: The Avi Publishing Co., Inc., 1934.) Price $2.25.

This should prove a useful "laboratory companion" to the above publication. It contains instructions for carrying out the various laboratory processes, together with descriptions of the apparatus used and a number of physico-chemical tables. As is explained in the introduction, it is written "from the point of view of the plant control chemist rather than from that of the food inspector," the examination of wines for adulteration being adequately covered in other text-books.

DIE KULTUR DES YLANG-YLANG- ODER KANANGABAUMES UND DIE VERWERTUNG SEINER PRODUKTE. By W. Hoffmann. Pp. 42, 8¼ × 5½. (Hamburg: Tropenverlag Fr. W. Thaden, 1934.) Price M.2.80.

The author of this interesting little work, published as No. 1 of the series of " Tropische Duftpflanzen (Ätherische Öle liefernde Pflanzen) " is Agricultural Engineer and Director of Plantations in Madagascar and is thus fully acquainted with the subject on which he writes.

After a general historical account of ylang-ylang and its distribution, a description of the tree is given and full information is afforded regarding its cultivation and the care of the plantations.

The following are some of the particulars recorded with reference to the production and collection of the flowers and their yield of essential oil. Flowers occur on the ylang-ylang tree all the year round, but the main flowering period in Madagascar lasts only from May or June to September, whereas in the Philippines, owing to the cooler dry period, the flowers can be obtained from March until November, the principal months being August and September. The flowers must be gathered in the early morning and before ten o'clock at latest, this being of great importance in relation to their oil-content. They must be conveyed to the distillery within three or four hours of their collection and on arrival must at once be placed in the still. It is estimated that when grown on good soil one tree, on the average, can produce 30–40 kilos. of flowers annually for a period of ten to fifteen years. The percentage of oil in the flowers varies with the type of tree, its position especially in relation to sunshine, the moisture-content of the soil and the weather at the time of harvesting. In Madagascar, Réunion and the Comoro Islands, the oil-content of the flowers usually ranges between 1½ and 2 per cent. Some planters, by carrying on the distillation for ten hours, obtain yields of 2½ and even 3 per cent., but the product is then of inferior quality. The first-class essence, sold as " Ylang-ylang," can only be obtained during the first two and a half to three hours' distillation, in which time the yield does not exceed 0·8–1·0 litre per 100 kilos. of fully developed flowers. Later fractions are less valuable and commercially are usually designated as " Cananga " oil.

Methods of distillation and the forms of still used for the purpose are described with the aid of diagrams.

The work concludes with a discussion of the fall in prices of the oils during recent years, which was due to over-production caused by the rapid extension of planting that took place during the " boom " in the years 1925–8. The author considers that the number of trees under cultivation is still much too high for firmer prices to be established, and adds that better prices cannot be expected if the planters extract the whole of the oil from the flowers. He strongly advises producers to aim at quality rather than quantity.

COTTON: FROM THE RAW MATERIAL TO THE FINISHED PRODUCT. By R. J. Peake. Fourth Edition, Revised and Enlarged by H. P. Curtis, F.T.I. Pp. xii + 216, 8½ × 5½. (London: Sir Isaac Pitman & Sons, Ltd., 1934.) Price 5*s*.

This work represents the fourth edition of Peake's little book, originally published in 1909 in the series of " Common Commodities of Commerce." It has been thoroughly revised and greatly enlarged, and the second chapter on " Cotton Growing " has been completely re-written by the well-known authority, Mr. John A. Todd. Other chapters deal with the manufacturing processes of spinning, winding, warping, weaving, bleaching, printing and dyeing, etc., and also include information regarding the market distribution of yarn and cloth, trade unions, masters' organisations, and such bodies as the British Cotton Growing Association, the Empire Cotton Growing Corporation and the British Cotton Industry Research Association.

The book is written, so far as possible, in non-technical language and is copiously illustrated. In its revised form, its value to textile students is much enhanced and it will continue to be of service to all who are interested in the subject of cotton, whether from the producing, marketing or manufacturing standpoint.

GEOLOGIC STRUCTURES. By Bailey Willis and Robin Willis. Pp. xviii + 544, 7½ × 5. Third Edition, Revised. (New York and London: McGraw-Hill Book Company, Inc., 1934.) Price 24*s*.

This third edition of " Geologic Structures " is not a mere revision of the second edition. It is a complete rearrangement, and much new matter has been added to increase its usefulness and bring it up to date.

An opening chapter deals with the problem of rock deformation, and points out how relative is the scale of effects to be considered in dealing with earth structures, large in relation to human standards, but very small when measured against the magnitude of the earth as a whole. It is this latter relation that has to be kept well in mind when dealing with such problems as mountain growth and the many aspects of structural geology.

Chapter 2 deals with the mechanical principles involved in structural changes, while Chapter 3 deals briefly with a few of the simpler aspects of stratified rocks. Then follow six important chapters dealing with flexures, folds, joints and faults. In these chapters the reader is first given a description of the type of structure dealt with in each case, this being followed by an analysis of the stresses and strains involved in the production of the structural feature referred to.

Separate chapters, 10 to 15 respectively, are devoted to structures in igneous rocks, structures in metamorphic rocks, the physiographic expression of structure, field methods, graphic methods and practical problems. In the chapter on field methods (pp. 292–325) Bailey Willis gives the reader the very substantial benefit of his large experience as a far-travelled field worker. Every student of structural geology should take seriously and act upon the excellent advice given in the closing paragraphs of this chapter.

The last chapter on fundamental facts and concepts is full of interest. A series of four appendixes and a good index conclude the book, which is well illustrated and altogether very good value.

ARSENICAL AND ARGENTIFEROUS COPPER. By J. L. Gregg. Pp. 189, 9 × 6. (New York: The Chemical Catalog Company, Inc., 1934.) Price $4.00.

This is an American Chemical Society Monograph dealing with the arsenical and argentiferous copper which is obtained from many of the Lake Superior mines. Copper of this type possesses certain advantages over electrolytic copper for some industrial purposes, and the book has been written to draw attention to this fact and incidentally to give an account of the metallurgical processes used in the refining of copper in the Lake Superior region. In comparing these types of copper much general information about the metal has been included, and the book is thus of wider interest than its title implies.

The addition of arsenic to copper increases its resistance to corrosion, both atmospheric and under oxidising conditions at high temperature. The main effect of silver is to raise the annealing temperature of copper with but slight lowering of the electrical conductivity. Arsenical and argentiferous coppers are thus suitable for many special purposes which are described in the final chapter.

The opening chapters contain an account of the development of copper mining and metallurgy from ancient times and a general description of the properties and uses of copper. The smelting and refining of arsenical and argentiferous copper are dealt with in detail, followed by a discussion of recent work on the copper-oxygen, copper-arsenic and copper-silver systems. The effects of arsenic and silver upon the electrical, thermal, mechanical and corrosion-resisting properties of copper and its alloys are then described.

An appendix includes statistics of copper production and prices, particulars of wire gauges and specifications for copper for various purposes. The bibliography is fairly comprehensive and up to date.

The book will be of service to users and producers of copper for its valuable survey of existing knowledge and indications of further uses for the metal and its alloys.

TRANSVAAL GOLD AND BASE METALS LAW. By Manfred Nathan, K.C., LL.D., Assisted by Selwyn Curlewis, B.A. Fifth Edition. Pp. 273, 9¼ × 6. (Johannesburg: Hortors, Ltd., 1934.)

The Mineral Law Amendment Act No. 36, 1934, which came into force on July 1, 1934, has rendered necessary a new edition of Dr. Nathan's well-known work on the Transvaal Gold and Base Metals law.

In bringing his book up to date, he has adopted the method of incorporating the changes introduced by the Act of 1934 with the sections of the original Act of 1908, so as to present one complete statute, with the result that the Act of 1908 as amended may be read continuously and without the necessity of constant reference to the amending Act. As he points out, one of the main causes of the new Act of 1934 has been the gradual change in the character of mining, which has tended to pass more and more from the hands of the " small man " into those of the large corporation.

His task appears to have been discharged with the degree of competence that one would expect, and thereby a further spell of usefulness has been ensured for his book.

HANDBUCH DER ANORGANISCHEN CHEMIE. Edited by Dr. R. Abegg, Dr. Fr. Auerbach and Dr. I. Koppel. Vierter Band, Dritte Abteilung, zweiter Teil B, Lieferung 3. Verbindugen des Eisens. Pp. B xxi–B xxvi + B675–B875, 10 × 7. (Leipzig: Verlag von S. Hirzel, 1935.) Price RM.28.

This section of Abegg's " Handbuch " deals further with the compounds of iron, a number of homogeneous and heterogeneous systems in which iron or one of its compounds acts as a catalyst being considered in the first chapters. Descriptions of many important reactions, both inorganic and organic, are included ; and the process for the synthetic production of ammonia in which catalysts containing iron have been successfully used is of special interest.

A short account of the bio-chemistry of iron then follows. The rapid developments that have taken and are taking place in this and other borderland regions of chemistry made it inevitable that treatises such as this should widen their scope as time goes on. Thus, we are provided in this section with a very interesting discussion of the structure of hæmoglobin, which illustrates the important part played by iron compounds in physiological processes and shows the desirability of taking a wide view of the subject by introducing matters which many readers might not regard as strictly relevant in a " Handbuch " such as this.

The next section, dealing with the analytical chemistry of iron, contains much useful information. The use of organic reagents for " spot " tests, the determination of iron by volumetric, gravimetric and colorimetric methods and separation processes are all described. The methods used in the technical analysis of iron and steel, iron ores and slags, are also included.

The last hundred pages contain a detailed description of the chemical and physical properties of colloidal ferric oxide, colloidal solutions of other iron compounds being described in a few concluding pages.

COMMERCIAL ANALYSES OF SOUTH WALES COALS. By Llewellyn J. Davies, F.C.S., and D. Owen Davies, F.C.S. Fifth Edition. Pp. 73, 4 × 2¾. (Cardiff : The Business Statistics Company, Ltd., 1934.)

So popular has this small pocket-book proved, that five editions have appeared in as many years.

It is divided into two sections, the first giving three representative analyses of each of the numerous classes of coal produced in South Wales, and the second containing a tabular statement of representative proximate analyses of large coals supplied by each of the colliery companies. There are also notes on methods of analysis of coal and on the suitability of different classes of coal for various purposes.

It is a very useful little book, eminently suitable for the purpose for which it was prepared, namely to provide scientific information for merchants and buyers of South

Wales coal, in a handy form. One regrets that similar information is not so readily available for all the other British coals.

AKTIVE KOHLE UND IHRE VERWENDUNG IN DER CHEMISCHEN INDUSTRIE. By Dr. G. Bailleul, Dr. W. Herbert and Dipl.-Ing. E. Reisemann. Pp. 95, 10 × 6½. (Stuttgart: Ferdinand Enke Verlag, 1934.) Price RM.6.

So many new uses for active carbon have been discovered in the last twenty years that it has become a material of considerable industrial importance, many grades being now produced, each having some special application. This book, which is claimed by the authors to be the first complete account of active carbon, is therefore very welcome. The following summary is sufficient to show that it is a judicious blend of theory and practice which deserves to be widely read.

Dr. W. Herbert has contributed the section dealing with the manufacture and properties of active carbon, both the chemical and gas activation processes being considered. A detailed account of the physical chemistry of the adsorption phenomena governing the properties of active carbon is given.

Sections on the absorption of vapours by active carbon, particularly those of organic solvents, and the extraction of light hydrocarbons from natural gas, are by Dipl.-Ing. E. Reisemann.

Dr. Herbert has written the two following sections, one on the recovery of benzol from coal gas by active carbon. The importance of this process can be judged from the fact that the Gas Light and Coke Company, after much experiment, have installed an active carbon benzol recovery plant at their Beckton gasworks. The other section contains an account of the methods of testing the various grades of active carbon. These differ so widely in their properties that no general tests can be used, the methods employed having to be modified according to the uses of the material under examination.

Dr. G. Bailleul concludes the book with a description of the use of active carbon for decolorising various technical products such as oils, fats and sugar, and for removing small quantities of impurities, also its use in the purification of drinking water and industrial waste waters. In this connection it is stated that about four hundred waterworks in the United States have commenced using active carbon in the last three years.

THE PRINCIPLES OF MOTOR FUEL PREPARATION AND APPLICATION. By Alfred W. Nash, M.Sc., M.I.Mech.E., F.C.S., F.Inst.Fuel, and Donald A. Howes, B.Sc., Ph.D., A.M.I.P.T. Volume I. Pp. xiv + 538, 9¾ × 6. (London: Chapman & Hall, Ltd., 1934.) Price 30s.

The widely increasing use of internal combustion engines, and the vast amount of work which has been done in recent years on the production and improvement of the necessary fuels, render the publication of this book very opportune.

The first volume deals fully with the production of motor fuels by methods of distillation, cracking, extraction from natural gas, and hydrogenation. The production of benzole, alcohol and other synthetic fuels is not neglected, and a long chapter deals with the refining of motor fuels. Methods of storage, insurance and distribution are also considered.

In view of the standing of the authors, and the eulogistic words of Dr. A. E. Dunstan, of the Anglo-Persian Oil Co., in his foreword, the book can safely be recommended. It contains a wealth of information, and when the second volume is available the completed work will be a notable contribution to the literature of fuel technology.

THE STONE INDUSTRIES. By Oliver Bowles. Pp. xi + 519, 9 × 6. (New York and London: McGraw-Hill Book Company, Inc., 1934.) Price 30s.

It is a remarkable fact that although building stone is one of the most important mineral products, both from a utilitarian and a commercial point of view, there are comparatively few text-books on the subject. Certainly none of recent date covers the whole field in the way that this one does, and it is therefore very welcome.

After a short introductory statement dealing with general features of the industry comes the main section of 348 pages devoted to dimension stone, in which a chapter is given to each class of stone, limestone, sandstone, granite, etc. First the general characteristics are given, such as chemical and mineral composition, texture, colour, varieties and uses, and then follows an account of the deposits of the United States, the production by States, methods of quarrying and working up into various products, marketing, prices and bibliography. Each class of stone is dealt with thoroughly, and although the information is chiefly of interest to American readers, there is much of practical value to those engaged in the stone industry in other countries. A comprehensive chapter is also devoted to foreign building stones, while others describe miscellaneous rocks used mainly for ornamental purposes and the deterioration, preservation and cleaning of stonework.

The third part of the book deals in 122 pages with the crushed-stone industry, most of which is taken up by the consideration of crushed and broken limestone, the condition of the industry in the various individual States of the U.S.A. being given detailed consideration.

The book can be highly recommended, as it is full of useful information and deals with a subject which, although one of much economic importance, has not in the past received the attention it deserves.

ROAD MAKING AND ADMINISTRATION. By Percy Edwin Spielmann, Ph.D., B.Sc., F.I.C., A.R.C.Sc., A.Inst.P., and Ernest John Elford, M.Inst.C.E., M.I.Mech.E., M.T.P.Inst. Pp. x + 441, 9 × 5¾. (London : Edward Arnold & Co., 1934.) Price 25*s.*

THE TESTING OF BITUMINOUS MIXTURES. By Donald C. Broome, F.C.S., M.Inst.P.T., etc., and R. O. Child. Pp. vii + 194, 9 × 5¾. (London : Edward Arnold & Co., 1934.) Price 15*s.*

These books form the first two volumes of " The Roadmaker's Library " (General Editor, Dr. Percy Spielmann), which is intended " to provide a series of volumes of a nature to command the interest and confidence of all who seek an authoritative account of the various aspects of road making and its allied subjects."

Road Making and Administration gives a comprehensive account of the construction and maintenance of roads, due regard being paid to such essential factors as safety, slipperiness and noise. The authors have consistently aimed at giving as disinterested an account as possible ; and the descriptions of the various materials and processes are refreshingly free from commercial bias. They have, at the same time, treated the subject broadly, suggesting useful lines of research, without losing sight of the fact that roads involve social as well as technical problems. In this connection, the chapters on " Public Relations " and " Administration and Law " are of considerable general interest, and could be profitably read by everybody.

The scientific aspect of road work is treated at some length, and various appendixes and a good bibliography conclude a useful, well-illustrated book.

The Testing of Bituminous Mixtures is essentially a laboratory manual, and represents an excellent attempt to bring together all the methods available for testing bituminous road mixtures. Where alternatives exist, the choice of a method is naturally a matter of personal preference, being governed by such factors as familiarity, peculiarities of the material, etc. The author has avoided the mistake sometimes made of condemning all methods except those with which he is familiar.

A chapter on "Special Tests in connection with Roofing Felts," by R. O. Child, is well written and useful, but seems somewhat out of place in the "Roadmaker's Library."

DUST. By S. Cyril Blacktin, B.Sc., M.Sc., Ph.D., A.I.C. Pp. xi + 296, 8½ × 5½. (London: Chapman & Hall, Ltd., 1934.) Price 18*s*.

This book is essentially a review of the literature available regarding dust, which, according to the author's rather ponderous definition, "is a powdered or finely-divided form of homogeneous or heterogeneous solid substances, mixed with or without any due regard to, or any immediate knowledge of, particle-size difference or limits, proportionality, or condition, amongst its parts." It thus includes all finely-divided material, whether natural or artificial, and its importance, therefore, both from a scientific and industrial point of view, is apparent.

The information which is presented in this work has been grouped under eight main headings as follows: Dust in General, Dust in Nature, Dust in Everyday Experience, Dust in Experimental Sciences, Dust in Geology, Dust in Botany, Dust in Industry and Technology, and finally, Dust in Pathology and Physiology. In addition, there is a brief introduction and a list of 545 references to the subject, as well as an author index and a subject index.

Throughout the text liberal use is made of mathematical illustrations, the author calculating, for instance, that the number of particles of rubber dust, due to the annual wear and tear of motor tyres in the United Kingdom, is some 37,000 for each breath taken by each person in the country. The corresponding figure for the United States is given as 133,200 particles per breath, per person. Tobacco-ash dust produced annually in Great Britain is estimated to yield 25,500 particles per inspiration per person, while the annual production of fuel-waste, or soot, stated in 1921 to be equivalent in weight to three days' national output of coal, is calculated to give 13 million particles per inspiration per person. A further calculation is given to show that a constant wind of 14 miles per hour would take about 10,000 years to remove all the Chinese loess deposit from the Gobi Desert. Such calculations are, however, necessarily based on numerous assumptions, and are consequently of doubtful value. They do, however, serve to indicate the immense quantities of material that go to make the " dust atmosphere," which the author, for a number of reasons, prefers to call the " staubosphere."

The book contains a large amount of information, but defects of literary style, and the author's frequent use of elaborate mathematical calculations, many of which appear unnecessary, detract from its value.

CONDUCTOMETRIC ANALYSIS. PRINCIPLES, TECHNIQUE, APPLICATIONS. By Hubert T. S. Britton, D.Sc., B.Sc., D.I.C., F.I.C. Being Volume Eight of a Series of Monographs on Applied Chemistry under the editorship of E. Howard Tripp, Ph.D. Pp. xi + 178, 8½ × 5½. (London : Chapman & Hall, Ltd., 1934.) Price 12*s*. 6*d*.

The possibility of following analytical reactions by means of conductivity determinations has been recognised for some time. The original procedure was clumsy and it is only recently that convenient visual methods for observing the end-point have been introduced. This advance has made it possible to employ conductometric methods in the works laboratory where the older telephone type of indicator was difficult to work successfully. This volume is therefore likely to arouse much interest.

The main portion of the book consists of a description of the types of apparatus which have been suggested for carrying out the determinations, together with a full account of the physico-chemical principles involved. A considerable theoretical knowledge is necessary for the interpretation of the results obtained and an understanding of these chapters is essential for the successful application of the methods. A number of neutralisation or precipitation reactions to which conductometric methods have been applied, with varying success, are next described, and an account of many of the author's own investigations is given.

The last chapter deals with the industrial applications of conductometric analysis. Industrial chemists have been the first to apply these methods, which are very conveniently adapted to the automatic control of technical processes and to routine testing. The possibilities of conductometric control have not yet been fully investigated, and further developments may be anticipated.

Owing to the cost of the apparatus, the difficulty of acquiring a new technique, and the special conditions under which most of the titrations have to be performed, these methods are not likely to prove attractive at present to the analyst who has to examine a wide range of materials at short notice.

RÉPERTOIRE INTERNATIONAL DES SOCIÉTÉS ELECTROCHIMIQUES ET ELECTROMÉTALLURGIQUES, 1934. Pp. 206, 9½ × 6¼. (Paris: Société des Publications Minières et Métallurgiques, 1934.) Price 74 Francs.

This is the first edition of a directory of the electrochemical and electrometallurgical industries of the world. The main portion of the book is occupied with lists of the firms engaged in these industries in each country, and of the scientific and technical societies specialising in electrochemistry and electrometallurgy and the journals dealing with these subjects.

An introductory section deals with topics of general interest. The world production of electrical power and the chief electrochemical products are summarised, and the development of industrial electrochemistry from the pioneer work of Moissan is briefly reviewed. Regulations for the packing and transport of calcium carbide and ferro-silicon are included.

The statistics given in this book emphasise the minor place which this country occupies among the producers of certain electric-furnace products, such as the ferro-alloys used in the manufacture of special steels, owing to the absence of any considerable source of cheap hydro-electric power. Some electricity is generated by water power in Scotland, but taking Great Britain as a whole, only 3 per cent. of the total electric power produced is obtained in this way. It is obvious that a cheap and reliable supply of electric power is necessary for the metallurgical industries of this country to meet competition from other countries endowed with abundant water power.

BOOKS RECEIVED FOR NOTICE

EASTERN AFRICA TO-DAY AND TO-MORROW. Compiled and Edited by F. S. Joelson. Pp. xvii + 376, 10 × 6½. (London: "East Africa," 1934.) Price 7*s.* 6*d.*

THE SOUTH AND EAST AFRICAN YEAR BOOK AND GUIDE FOR 1935. Edited for the Union-Castle Mail Steamship Co., Ltd., by A. Samler Brown, F.R.Met.S., and G. Gordon Brown, F.R.G.S. Pp. lxvi + 1130, 7 × 5. (London: Sampson Low, Marston & Co., Ltd., 1934.) Price 2*s.* 6*d.*

ECONOMICS WITH APPLICATIONS TO AGRICULTURE. By Edwin F. Dummeier, Ph.D., and Richard B. Heflebower, Ph.D. Pp. x + 742, 9 × 6. (London: McGraw-Hill Publishing Co., Ltd., 1934.) Price 22*s.* 6*d.*

GARDENING IN EAST AFRICA: A PRACTICAL HANDBOOK. By Members of the Kenya Horticultural Society and of the Kenya and Uganda Civil Services. Edited by A. J. Jex-Blake, M.D., F.R.C.P. Pp. xv + 330, 8½ × 5½. (London, New York and Toronto: Longmans, Green & Co., 1934.) Price 12*s.* 6*d.*

THE GENETICS OF GARDEN PLANTS. By M. B. Crane and W. J. C. Lawrence. Pp. xvi + 236, 9 × 6. (London: Macmillan & Co., Ltd., 1934.) Price 10*s.* 6*d.*

TROPISCHE UND SUBTROPISCHE WELTWIRTSCHAFTSPFLANZEN, IHRE GESCHICHTE, KULTUR UND VOLKSWIRTSCHAFTLICHE BEDEUTUNG. By Prof. Dr. Andreas Sprecher von Bernegg. III Teil, 2 Band: Kaffee and Guaraná. Pp. xi + 286, 10 × 6½. (Stuttgart: Verlag von Ferdinand Enke, 1934.) Price, paper cover, RM.21; bound, RM.23.

THE DISEASES AND CURING OF CACAO. By H. R. Briton-Jones, D.Sc., Ph.D., D.I.C., A.R.C.S. Pp. x + 161, 9 × 6. (London: Macmillan & Co., Ltd., 1934.) Price 10*s.*

ORANGE AND LEMON CULTURE IN INDIA. By D. E. Lowrie. Pp. 80, 7½ × 5. (Bombay: The *Times of India* Press, 1934.) Price Rs.1, As.12.

FATS AND OILS STUDIES OF THE FOOD RESEARCH INSTITUTE, STANFORD UNIVERSITY, CALIFORNIA.—No. 5, June 1934. The American Vegetable-Shortening Industry. Its Origin and Development. By G. M. Weber and C. L. Alsberg. Pp. xii + 359, 8¾ × 5¾. (London: P. S. King & Son, 1934.) Price 14*s.*

THE NATURAL ORGANIC TANNINS. HISTORY: CHEMISTRY: DISTRIBUTION. By M. Nierenstein, D.Sc. Pp. vii + 319, 8¾ × 5½. (London: J. & A. Churchill, Ltd., 1934.) Price 21*s.*

LOGGING—PRINCIPLES AND PRACTICES IN THE UNITED STATES AND CANADA. By Nelson Courtlandt Brown. Pp. xvii + 284, 9 × 6. (New York: John Wiley & Sons, Inc.; London: Chapman & Hall, Ltd., 1934.) Price 21*s.* 6*d.*

BUCH DER HOLZNAMEN. By Dr. Hans Meyer. III. Ishan—Murere vermelho. Pp. 120, 10 × 7. (Hanover: Verlag von M. & H. Schaper, 1934.) Price M.6.50.

DEPARTMENT OF SCIENTIFIC AND INDUSTRIAL RESEARCH: REPORT OF THE COMMITTEE ON THE MECHANICAL TESTING OF TIMBER. Pp. vi + 41, 9½ × 6. (London: His Majesty's Stationery Office, 1934.) Price 1*s.*

VETERINARY HYGIENE. By R. G. Linton, Ph.D., M.R.C.V.S. Second Edition. Pp. xix + 472, 9¾ × 6. (Edinburgh: W. Green & Son, Ltd., 1934.) Price 21*s.*

INTRODUCTION AUX ETUDES MINIÈRES COLONIALES. Pp. viii + 349, 9½ × 6½. (Paris: Société d'Editions Geographiques, Maritimes et Coloniales, 1934.) Price 36 Fr.

CRYSTALS AND THE POLARISING MICROSCOPE. A Handbook for Chemists and Others. By N. H. Hartshorne, Ph.D., M.Sc., and A. Stuart, M.Sc., F.G.S. Pp. viii + 272, 8½ × 5½. (London: Edward Arnold & Co., 1934.) Price 16*s.*

INTERNATIONAL COMBINES IN MODERN INDUSTRY. By Alfred Plummer, B.Litt., M.Sc. (Econ.), LL.D. Pp. ix + 191, 8½ × 5½. (London: Sir Isaac Pitman & Sons, Ltd., 1934.) Price 7*s.* 6*d.*

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